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Making Sustainability Operational
Fourth Mexico/U.S. Symposium

Haciendo Operaciona
a la Sostenibilidac
Cuarto Simposio Mexico/EUA

April 19-23, 199
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Abstract

This proceedings is the product of a Mexico/U.S. Symposium held at the Picacho Plaza Hotel, Santa Fe, New Mexico, 19-23, April, 1993. The symposium included presentations, panel discussions, poster sessions, and working groups to discuss the theme "Making Sustainability Operational." Sessions addressed the economic, social, and ecological aspects of sustainable integrated management of forests and ecosystems. All sessions had Spanish and English translations.

Symposium Chairs:

Hugo Manzanilla, Vocal Forestal
Instituto Naciónal de Investigaciónes Forestales y Agropecuarias
Secretaria de Agricultura y Recursos Hidraulicos

and

Douglas Shaw, USDA Forest Service
Watershed and Air Management
Southwestern Region

The shaking hands symbolize the cooperation among many cultures of the world that is necessary to make sustainability operational.

USDA Forest Service
General Technical Report RM-240

December 1993

Making Sustainability Operational: Fourth Mexico/U.S. Symposium

Haciendo Operacional a la Sostenibilidad Cuarto Simposio Mexico/EUA

April 19-23, 1993
Santa Fe, New Mexico

Technical Coordinators:
Hugo Manzanilla, INIFAP
Douglas Shaw, USDA Forest Service
Celedonio Aguirre-Bravo, USDA Forest Service
Leonel Iglesias Gutierrez, INIFAP
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Sponsors:
Instituto Nacional de Investigaciones Forestales y Agropecuarias
Secretaria de Agricultura y Recursos Hidraulicos
U.S. Department of Agriculture, Forest Service: Rocky Mountain Forest and Range Experiment Station and Southwestern Region

**Rocky Mountain Forest and Range
Experiment Station
U.S. Department of Agriculture
Fort Collins, Colorado**

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Denver Burns[1]

Dear Colleagues from Mexico and the United States:

I am honored to represent the Rocky Mountain Station in this Fourth International Symposium on Sustainability. As the theme of this symposium suggests, "Making Sustainability Operational" is a fundamental challenge of multiple complexities and of global dimension. In fact, making sustainability operational is an issue that concerns us all. But, before I proceed, let me take this opportunity to welcome you all.

It is with great satisfaction that I meet with you again in this symposium to continue supporting our bilateral efforts of forestry cooperation. Many of you from the United States are already well acquainted with our colleagues from Mexico. However, I want to take this opportunity to introduce to you Dr. Hugo Manzanilla, INIFAP's Deputy Chief of Forestry Research, and Carlos Gonzalez Vicente, representing Dr. Ernesto Samayoa, Chief Executive of INIFAP. I am confident this event will bring to us plenty of opportunities for interaction so that we may become better acquainted. It is also an occasion for expanding understanding and enhancing our linkages for future cooperation.

Our two countries have a long history of productive forestry cooperation. Records of this cooperation go back as far as 1911, that is, six years after the Bureau of Forestry was established to manage the expanding Forest Reserve System. As you know, this Bureau later became the USDA Forest Service of today. Central in this cooperation has been the dynamic role played by our respective Departments of Agriculture. In Mexico, SARH's Undersecretary of Forestry and INIFAP have been the most important players. Within the USDA Forest Service, these functions have been the responsibility of Research, State and Private Forestry, and more recently of International Forestry. Since that beginning, our agencies have signed several agreements on Forestry cooperation which have evolved along with our institutional growth. Currently, these cooperative efforts are supported by the following agreements:

1. The North American Forestry Commission;

2. The 1984 Memorandum of Understanding on Scientific and Technological Cooperation in Forestry, as supplemented in 1985;

3. The Letter of Intent on Forestry Research, signed on July 24, 1992.

A Regional Agreement, however, to establish technical and scientific cooperation in forestry was signed in 1981 between the former National Institute of Forestry Research (which today is part of INIFAP), the Rocky Mountain Forest and Range Experiment Station, and the Southwest Region of the USDA Forest Service. Generally, these agreements, as Carlos Gonzalez expressed in our prior symposium in Morelia, represent the most successful mechanisms for understanding and friendship between our two countries. In fact, the past three symposia constitute a tangible measure of our growing relationship. There is no doubt that our countries have benefitted greatly from the diversity of opportunities brought about by these bilateral cooperative agreements.

After almost a century of growing interaction, our cooperative activities continue maturing and gaining momentum. Every year numerous scientists and experts from our institutions interact effectively in conducting projects of research and technology transfer in natural resource related areas. Traditionally, collaborative projects have been undertaken in the fields of silviculture, forest biometry, forest management and harvesting, watershed and fire management, and information management technologies. In contrast to previous decades, however, current forestry cooperation is becoming more diverse and is involving a more diversified work force of natural resource professionals. Many of these cooperators are not only from federal and state agencies, but also from universities and nongovernment organizations.

Today, the focus of forestry cooperation is rapidly changing from a commodity oriented strategy of resource utilization, to a more socially driven ecosystem value approach to resource management. New socio-economic conditions and a growing diversity of participants from a broad array of constituencies are inducing these accelerated changes. In many ways, these changes are significantly influencing the programmatic philosophy of the U.S. Forest

[1] *Station Director, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.*

Service as well as its mission and goals. For instance, "The goal of Forest Service Research is to serve society by developing and communicating the scientific information and technology needed to protect, manage, and use the natural resources of forests and range lands." Our strategy to achieve this goal requires the establishment of joint cooperative ventures and partnerships with national and international organizations. Global involvement is essential in this strategy. This conviction, as it is expressed in the Letter of Intent on Forestry Research, constitutes a fundamental principle in research cooperation between our countries.

As we enter the 21st Century, the need for international cooperation is becoming more evident. Natural ecosystems are the "common ground" upon which all nations interact, subsist, and benefit. Our life support systems are linked inextricably to complex phenomena of ecological and environmental dimensions that operate at various levels of scale. As a whole, our "common ground" is spatially interconnected and our dependencies are not constrained by geopolitical boundaries. Our interactions with this "common ground", given by the pressures of a growing population and the liberalization of trade policies, have increased the complexity of world-wide interdependencies. To our countries, part of this complexity is exemplified by the North American Free Trade Agreement (NAFTA). We are beginning to realize that progress, without sense and direction, conflicts with the evolving values of a more conscious society. Confronting these challenges will demand more international collaboration and participation.

This new set of emerging conditions, which creates and emphasizes biophysical and socio-economic continuities, is making the tasks and linkages of our scientists more global in scope. In response to these needs, the Chiefs of our respective agencies have initiated important actions to increase research cooperation between our countries. First, the meeting in Tapalpa (Mexico) where we signed The Letter of Intent on Forestry Research. Two months later, the meeting in Fraser (Colorado) where our scientists got together to develop and define strategies for research cooperation. Then we met in Campeche (Mexico) to follow up previous activities and to learn more about the nature of forestry research in Mexico. At this point, there are several formal proposals for research and technology transfer developed jointly by INIFAP and Forest Service scientists. Funding these proposals will be critical to provide continuity to these actions.

Fundamental to our cooperation is the creation of linkages with which to anchor current and future actions between our institutions. In this process, there are no single actors, but integrated actions in which we all share mutual responsibilities to face common challenges. Likewise, there are no single answers to confront global problems. This symposium in Santa Fe, and others yet to come, will provide opportunities to exchange and pool our ideas and resources to meet common challenges. By participating in this symposium, we are planting the seeds for promoting scientific interaction to advance forest science and technology between our two nations. We all know that this is a continous process, which in order to enhance it and sustain it, will require our effective participation and commitment. Eventually, the seeds we have planted will multiply, not only in the number of participating scientists, but also in improving their scientific talents and skills.

I thank you for being here and for your participation at this symposium.

INTERVENCION EN LA CEREMONIA DE INAUGURACION

Ernesto Samayoa Armienta[1]

Quiero agradecer, en primer lugar la honrosa invitación que se me ha hecho para participar en la ceremonia de inauguración de este Cuarto Simposio Internacional entre México y los Estados Unidos de Norteamérica. El tema central de la reunión tiene en el momento actual una relevancia de nivel mundial. Sin duda que las aportaciones de los que en el curso de la presente semana intervendrán con sus documentos, se sumarán al gran cúmulo de ideas para resolver el buen uso de los recursos naturales y con ello poder contribuir al propósito de la sostenibilidad de los mismos.

Saludo con el afecto de siempre a los amigos del Servicio Forestal de los Estados Unidos con los que hemos tenido las oportunidad de estar juntos varias veces durante el curso de un año, ya que a partir del mes de julio anterior se han celebrado reuniones de gran importancia, tanto en México como en este país, y en ellas hemos coincidido algunos de los que en esta reunión nos encontramos.

Ya hace más de doce años que se llevó a cabo la primera reunión conjunta de este tipo, en la Ciudad de La Paz en Baja California Sur, para tratar el tema "Inventarios de Recursos de Zonas Aridas". Posteriormente se acordó el desarrollo de eventos científicos y técnicos para promover y fortalecer el intercambio entre las partes, eventos en los que participarían expertos de ambos paises.

Sobre este marco , en el año de 1985 se efectuó la reunión sobre "Manejo y Utilización de las Plantas de Zonas Aridas", como un evento previo a la celebración del IX Congreso Forestal Mundial que se realizó en la Ciudad de México ese mismo año.

La siguiente reunión denominada "Estrategias de Clasificación y Manejo de Vegetación Silvestre para la Producción de Alimentos en Zonas Aridas", se efectuó en la Ciudad de Tucson, Arizona en octubre de 1987. Esta fué muy concurrida y en ella participaron alrededor de 130 personas.

El tercero de estos eventos científicos conjuntos se llevó a cabo en la Ciudad de Morelia, Mich., durante el mes de marzo de 1990, bajo el título "Simposio Internacional: Manejo Integrado de Cuencas para Uso Múltiple", al cual acudieron igual número de asistentes que en la anterior reunión de Tucson.

Nos toca ahora, asistir con mucho agrado a la apertura del Cuarto Simposio Internacional sobre Sostenibilidad, en esta hermosa Ciudad de Santa Fe, tan llena de historia y de una gran hospitalidad.

Al referirme al estrecho contacto que hemos tenido en el curso de un año, quiero hacer referencia a la gran disposición de colaboración en trabajos conjuntos que hemos encontrado entre los responsables de la investigación forestal, en los Estados Unidos con sus contrapartes mexicanas. Es muy agradable para mí referirles que durante el mes de julio anterior, en la ciudad de Guadalajara, Jal., pudimos firmar una Carta de Intención, que establece compromisos y deberes mutuos para la realización de proyectos de importancia relevante para ambos paises en materia forestal.

A partir de entonces hemos coincidido en la reuniones celebradas en Frazer, Colorado, EUA., Campeche, Cam., México y en las que hemos podido dar seguimiento a los proyectos y acciones conjuntas.

En la Reunión de Campeche, se pudieron analizar los primeros proyectos, y se tuvo un mayor acercamiento de los líderes al estar intercambiando puntos de vista y experiencias en materia de desarrollo de proyectos de investigacion y así poder hacer propuestas que resulten de mútuo interés a los dos paises.

En ésta reunión tuvimos al oportunidad de contar con las valiosas opiniones de expertos del Servicio Forestal de los Estados Unidos, entre las cuales quiero hacer mención, sin demérito a las demás, a la de mi amigo Dr Jerry Sesco, quién siempre ha tenido una gran disposición para brindarnos sus ideas. Estoy seguro de que esta reunión será altamente productiva, porque hay una gran comunicación entre los expertos que a ella concurren. En muchos foros mundiales, se están discutiendo los aspectos importantes ligados a la protección, conservación y uso racional de los recursos naturales.

[1]*Vocal Ejecutivo del INIFAP/SARH - México.*

Los gobiernos de los paises que tienen aún grandes reservas de áreas arboladas están impulsando acciones encaminadas a su preservación, esto refleja que en todos los sectores ya existe una marcada preocupación por mantener el equilibrio de los ecosistemas naturales.

Creo que todos alentamos una esperanza común, que es la de poder colaborar a que se logre ese equilibrio, entre el uso y la regeneración de los recursos que el hombre utiliza para proporcionarse bienes y servicios.

Deseo el mejor de los éxitos a esta noble empresa que este grupo, aquí reunido se ha echado a cuestas, al que, por supuesto, me uno para participar con el mejor de mis esfuerzos y espero que esta gran apertura que existe ahora para realizar los proyectos que hemos convenido conjuntamente, dure por mucho tiempo y que los expertos que vayan sumándose en las próximas reuniones tengan la misma mística que alentó a los que sembraron la semilla de estos fructíferos encuentros internacionales.

La amistad y el entendimiento que ha imperado en todas las reuniones que hasta el momento se han realizado, reflejan el espíritu de cooperación que existe entre investigadores, técnicos y directivos forestales de México y los Estados Unidos.

Este espíritu es el que, sin duda, asegurará el éxito en esta reunión y las siguientes, para bien de nuestros paises; de la investigación forestal y de la humanidad, que espera que pueda prolongarse por mucho tiempo la presencia de los recursos naturales con que se cuenta y que el sueño de la sotenibilidad pueda convertirse en una realidad palpable y permanentemente.

Dejo a todos mis mejores deseos y mis más afectuosos saludos.

MUCHAS GRACIAS.

Making Sustainability Operational

Forrest Carpenter[1]

Welcome to Santa Fe and to the Mexico/United States symposium on ecosystem sustainability.

The concept of ecosystem multiple use sustainability is one of the most important concepts of our generation. Much has been written in modern literature about ecosystems. Knowledgeable scientists and researchers are formulating and teaching many — and sometimes conflicting — theories. Some are saying we must stop harvesting our forests. Others are saying wise use of the resources is needed, but in a sustainable manner. Some theories are popular and receive support through the news media and political systems. Other equally credible theories are unpopular and are suppressed by our system.

Most people in Mexico and the United States have little idea what to believe about the state of our ecosystems. They have little time to worry about generations beyond their own children and grandchildren. These people need resources, and they want them now and in growing quantities. Our economic policies are not structured to value the distant future nor to consider the cost if we eliminate our future resource options.

The time is now to start making operational these concepts of ecosystem multiple use sustainability, the theme of this symposium. It is time to combine our ecological knowledge. We must define the desired future condition for our countries, and work together to achieve these conditions. Making sustainability operational is a moral obligation for all humanity. Although many in modern society have lost awareness of their tie to the land, we are, in fact, tied to it. It is up to us to start the dialogue that will awaken these concepts and bring them to realization.

Thank you for traveling to Santa Fe and for taking the time to enter into this dialogue. This is the fourth cooperative symposium we have shared with our Mexican colleagues. We have a long, successful history of working together. Making sustainability of resource management operational requires continued cooperation between our two countries.

The international boundary between Mexico and the United States means little in the concept of ecosystems. We share common river basins — such as the Colorado and the Rio Grande — common airsheds, and common ocean currents. Our life support systems are linked by these common components of the global system. Activities in northern Mexico can affect high mountain lakes here in New Mexico's Sangre de Cristo mountains, and activities in New Mexico can affect northern Mexico. We must continue to learn, share technology, and manage to protect these resources for our own and future generations.

The Southwestern Region of the U.S. Forest Service is committed to this cooperation. We are currently implementing an initiative to improve our mangement of woodland vegetation to improve watershed conditions. Jose Salinas, our Regional Watershed and Air Director, has the lead in this initiative, replacing Noel Larson. Jose will also take the lead in our cooperative watershed management efforts with Mexico.

I hope you from Mexico will share with us your knowledge and experiences in managing woodlands. We will gladly share our knowledge with you. This is a small step, but there are many other opportunities, some that will be discussed this week — including cultural, economic, and ecological opportunities.

Thanks again for coming to Santa Fe. Enjoy this beautiful land, and the many cultures of northern New Mexico.

[1] *Deputy Regional Forester--Resources, USDA Forest Service, Southwestern Region.*

History of New Mexico and Land Use

Robert J. Torrez[1]

New Mexico has a long and eventful history. It is a history which is eclipsed only by the even longer and more eventful history of Spain, our father country, which brought us our Spanish language and the teachings of our Holy Catholic Church; but especially, the history of Mexico, our mother country, from whom we inherited our heart and our soul.

When Alvar Nunez Cabeza de Vaca and his companions emerged at Culiacan in 1536, after spending nearly eight years wandering the Gulf Coast and what is now the American southwest, they brought with them vague rumors of rich and glorious cities which were supposed to exist deep within the interior of this vast unexplored continent. In 1539, an expedition led by the Franciscan friar Marcos de Niza seemed to confirm these tantalizing stories. It was an exciting time, according to the historian Herbert Eugene Bolton, when "Imagination and gossip were unhampered by knowledge."

Our forefathers were certain that El Dorado, the golden cities of Cibola, and Gran Quivira - lay just over the horizon. In 1540, a gentleman by the name of Francisco Vasquez de Coronado was given the task of marching north to discover these untold riches - to discover another Mexico; perhaps another, or "new" Mexico, which would prove as rich as the Mexico they had only recently been conquered.

We know, however, that Vasquez de Coronado did not find the expected riches. For two years, his expedition penetrated deep into the North American continent, reached the plains of present-day Kansas, before returning to Mexico in 1542, devastated at not finding the elusive golden cities.

They did, however, find another resource which was just as valuable to the Spanish as gold. They found dozens of villages inhabited by agricultural peoples. Here were many thousands of souls to be saved by Christianity!

The Spanish called these aboriginal villages and towns, pueblos. Today, the descendants of these peoples live, work, and worship, in the nearly two dozen surviving pueblos, most of which, are in the same locations found by Vasquez de Coronado's expedition more than 450 years ago.

But it took nearly fifty years after Vasquez de Coronado, before any action was taken to colonize this new Mexico. In 1595, Juan de Onate, was contracted by the Spanish crown to establish a colony, several hundred miles from the nearest mining settlements of northern Mexico. In January 1598, the enormous caravan left Compostela, to begin its long march north towards the Rio del Norte, which we know today as the Rio Grande.

When the expedition reached the river crossing where Cuidad Juarez is today, Juan de Onate took formal possession of this new province in the name of King Philip of Spain. As they traveled slowly north along the Rio Grande, he took great pains to stop at each Indian settlement and obtain the inhabitants' formal allegiance to the King of Spain, and to their new God. We do not know if these new Spanish subjects knew what they had done, or how they felt about it.

In July 1598, the expedition arrived at the Tewa villages located where the Rio Grande and the Rio Chama meet. Here they stopped at the village of OKHE, renamed it San Juan de Los Caballeros, and established the first Spanish capitol of New Mexico. A few months later, the Spanish moved west of the Rio Grande to the pueblo of Yunque, renamed it San Gabrial, and reestablished their Spanish capitol at this new site. San Gabriel served as the Spanish capitol until 1610, when Santa Fe, under the governorship of Pedro de Peralta, was established. And here we still are today.

During the first century of New Mexico's history, a string of Spanish settlements was established along a 200 mile segment of the Rio Grande, stretching between Socorro and Taos. Land was parcelled out among the colonists through a system of encomienda, which were not outright grants of land, but which gave the encomiendero, rights to the labor of a certain number of Indians within the encomienda.

We do not know much about how the encomienda functioned in New Mexico, due to the almost total lack of records regarding this system. If the experience elsewhere in New Spain is any guide, we can surmise that although the encomienda had numerous safeguards designed to prevent the Indians from becoming chatel slaves, it appears certain that in practice, the system developed many abuses. When combined with Spanish civil and church intolerance of Pueblo religious practices, and the systematic destruction of Pueblo kivas and sacred objects, it is no surprise that in August, 1680, in an uprising that is often characterized as the First American Revolution, New Mexico's Pueblos united to drive the Spanish out of the province.

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[1] *State Historian, New Mexico State Center and Archives, Santa Fe, NM.*

For twelve years, the Spanish remained in exile at El Paso del Norte, until Diego de Vargas, the new governor, began the Reconquista in 1692. For the remainder of that decade, New Mexico suffered terribly while Spain reconquered its lost province. But once the reconquest was complete, New Mexico entered the new century with a more tolerant attitude; an attitude which was born out of necessity.

During the 18th century, it became Spanish practice, if not policy, to be more tolerant of Pueblo religion and cultural ceremonies. This was partially because of the hard lessons of the Pueblo Revolt, but also because it became apparent that if New Mexico was to survive as a Spanish province, the conquerors would have to cooperate with their Pueblo neighbors to defend the colony's frontier against the various tribes and international pressures which besieged them from all directions.

It may be said that the ultimate success of the Pueblo Revolt, was that it forced the Spanish to change their attitudes towards the Pueblo peoples. It was these changes which enabled the Pueblos to maintain their languages, and to this day, conduct their ancient religious ceremonies.

The 18th century was a period of significant change in the way land was distributed in the province. Even before the reconquest had been completed, New Mexico's governors instituted a system of land tenure based on land grants. It was a system which deeply influenced the subsequent history of this region, and which left an enduring legacy that continues to effect the lives of many New Mexicans.

There are three basic types of land grants. The first of these, are the private grants made to individual Spanish subjects as rewards for their role in the reconquest and to encourage resettlement of the colony. These were intended for the personal use of the individual and his family. They were generally, but not always small, and could be sold once the individual met a specific requirement of possession.

The second are grants made by the Spanish government to the various Pueblos. While it may seem strange that the Pueblos could be given title to land that was, in fact, already theirs, these Pueblo grants served an important function by protecting Indian rights to the land adjacent to their communities. These Pueblo grants have generally withstood every test of the past three hundred years. They protected the Pueblos from encroaching neighbors, and provided them the right to develop the resources within the grant. These grants have been the basis for the Pueblos as they exist today, and one may wonder what might have become of our Pueblo neighbors if the Spanish system had not had the audacity to grant them formal title to their own lands.

The most prominent type of grant, and the one which most concerns New Mexicans today, was the community land grant. These grants were made to groups who agreed to establish settlements and cultivate the land within the grant. Many of these were made by the Spanish government in the 18th and early 19th centuries, and later, by the Mexican government, as a means of expanding and protecting New Mexico's vast frontier.

Generally, each individual in a community grant, was allotted a small parcel of irrigable land for cultivation, and on which to build a house. When the individual met a requirement of occupancy, he received title, or an hijuela, to this lot. The individual could then sell this land if he chose to do so. However, the unallocated land within the grant was reserved for the common use and benefit of all the grantees. They could use these common lands, or ejidos, to pasture their livestock, gather firewood and timber for their homes, hunt, and conduct all such activities necessary for their subsistence.

These common lands, however, could not be sold. It is these common lands which became the basis for much controversy and fraudulent activity following the occupation of New Mexico by the American army in 1846.

Land grants, and what happened to them after the American occupation, is an important part of our history. One of General Stephen Watts Kearny's first actions when he took possession of New Mexico, was to assure its citizens that their rights to property would be respected by the United States government. It also became quickly apparent that the precepts held by the new government as to what constituted legal title to property, was very different from those of the Spanish and Mexican governments.

In 1854, the United States Congress established the Office of Surveyor General, and gave it the authority to investigate claims to property in New Mexico and the other territories acquired from Mexico in 1848.

Normally, in order to validate a grant, an individual or group would present their documents, personally, or through an attorney, to the Surveyor General. After an investigation, the Surveyor General forwarded a recommendation to Congress. If Congress confirmed a claim, a survey was ordered, and eventually, a patent, or title to the grant was issued.

Between 1855 and 1891, the Surveyor General investigated 180 land grant claims from New Mexico. 135 of these were submitted to Congress, of which 46 were confirmed. After 1891, the Court of Private Land Claims reviewed an additional 282 claims from New Mexico, and approved 82. As we can see, many more claims were denied than approved.

It often took many ears, and much expense, for a claim to make its way through the adjudication process. Along the way, many legitimate claimants lost much of their land to the very attorneys which represented them and the politicians which were supposed to protect their interests.

During the later part of the 19th and early 20th centuries, millions of acres of land formerly in land grants, reverted to the public domain, and was sold or retained under federal ownership. A significant portion of our National Forests, for example, are former land grant properties.

Millions of acres also ended up in private hands. A principal figure in the privatation of grant lands was Thomas B. Catron. Catron was only one of many individuals involved in the many shady, if not fraudulent land grand adjudications. His name, however, emerges more frequently than most. He managed to gain outright ownership of, or an interest in many of New Mexico's land grants, and was once considered the largest private land owner in the country.

The process through which many of New Mexico's communities lost their common lands is too complex to discuss in the short time we have here. We can point out, however, that in the community land grant system, the ability of each individual to support his family, depended not on the ownership of land, but access to the common lands - the ejidos. While an individual owned only a few acres for cultivation and on which be built a home, the hijuela he obtained gave him access to the forests, pastures, and other resources of the grant. When the common lands began to revert to private ownership, communities began to lose access to the land they traditionally used to gather timber and firewood, and most importantly, graze their flocks.

In the 1890's, the realization they were losing their access to the common lands, and consequently, the ability to support their families, prompted many settlers in the San Miguel and Mora County region of northwest New Mexico to resist the fencing of former common lands. The Gorras Blancas, as they became known because of the white caps they wore, began an organized campaign of fence cutting and other violence against the new owners and those whom they felt were cooperating with the new regime.

The continuing, and often tragic legacy, of land grant adjudication, came to public attention the morning of June 6, 1967. That day, sharing the headlines of the Six Day War in the Middle East, were startling reports of another conflict unfolding in a remote, and heretofore unheard of, place in northern New Mexico, named Tierra Amarilla.

The Tierra Amarilla Courthouse Raid, as this incident has become known, occurred on June 5, 1967, when a group of armed men associated with the Alianza Federal de Mercedes, a land grant organization popularly known as the Alianza, entered the Rio Arriba County courthouse with the intent of affecting a citizens arrest on the District Attorney.

The raid went terribly wrong. The District Attorney was not there; shots were fired, and by the time the raiders retreated, hostages had been taken, a jailer and a police officer lay wounded. By the following day, hundreds of law enforcement officers, reinforced by a battalion of the New Mexico National Guard, and two M-40 antiaircraft tanks, descended on Tierra Amarilla, combing the surrounding villages and mountains in a massive manhunt for the raiders.

The raid and subsequent events, focused national attention on a curious, century old problem. It seemed that in this remote region of the state, many people had retained strong feelings that the land grants which had been made to their ancestors by the Spanish and Mexican governments, had been unjustly adjudicated.

Tierra Amarilla has a long and colorful history. The village derives its name from the Tierra Amarilla Land Grant, a community land grant made to Manuel Martinez and several followers by the Mexican government in 1832. In 1854, Francisco Martinez, Manuel Martinez' son and heir, submitted the grant to the New Mexico Surveyor General for confirmation as a private grant. The surveyor General apparently accepted Don Francisco's contention that the grant had been made to his father as a private grant, and recommended to Congress that it be approved as such. In 1860, Congress confirmed the grant to Francisco Martinez.

Despite the fact the grant was sold, the settlers, retained the hijuelas which had been given to them when they were allocated parcels of land in the grant. These hijuelas contain the conditions specified by the Mexican government when it issued the grant in 1832, giving each holder of an hijuela unrestricted use of the pastures, timber, water, and roads within the grant boundaries. For more than a century, holders of these hijuelas have maintained that these documents guarantee their right to use the common lands - even after Thomas B. Catron obtained ownership of most of the 600,000 acre grant through a quiet title suite in 1883.

The human and land use legacy which we have today in Tierra Amarilla, as in other parts of New Mexico, derives directly from the manner in which many land grants such as this were adjudicated.

We need to keep in mind that the livelihood of every settler in a community land grant depended on their access to the common lands. It was this right that the stipulations on the hijuelas sought to protect. In Tierra Amarilla, Catron, as the new owner of the grant, apparently did not aggressively limit the resident's access to traditional common lands. Instead, he concentrated on allowing development of railroads through the grant, which in turn enabled the harvesting of the region's massive pine forests, development of coal mines, and lease of its lush grazing lands to large cattle interests.

While all this was occurring, prosperity apparently prevailed in Tierra Amarilla, and generally, few problems became obvious while settlers retained some access to traditional common lands. This changed however, after 1909, when Catron sold the grant, and its new owners began to fence off large portions of the grant.

Within a few years, realization of what was happening, prompted several incidents of fence cutting and haystack burning. One of the most serious of these incidents occurred in 1940, when several miles of fence were cut at various segments of the grant. A state policeman was dispatched from the capitol at Santa Fe to investigate, but found nothing. Instead, he was dismayed at the public support he found for the fence cutting.

"The people...feel as though the land belongs to them and should not be fenced," he reported. "They are living under the illusion that years ago the Tierra Amarilla grant was disposed of by the...[owners]...to Catron without [their] consent..." The policeman was incredulous that sixty years after the grant had been patented by the United States government to Thomas B. Catron, local residents still felt they had a right to graze their flocks on the traditional ejidos.

What may be even more incredible, is that although another fifty years have passed since this report, events of the last five years, seem to indicate this attitude still prevails among many residents of Tierra Amarilla.

In 1988, a man named Amador Flores again focused national attention on Tierra Amarilla and the land grant issue when he defied an Arizona land development company which sought to evict him from land he claimed was his. Flores and several supporters turned the land in question into a armed camp and defied authorities to place the development company in possession of the land. This time however, the specter of the Rio Arriba Courthouse, standing in full view, less than a mile away, helped cooler heads to prevail. A peaceful solution was reached through the courts, and ultimately, Flores' claim to the land was upheld.

At the same time as the Flores case was making its way through the courts, Ganados del Valle, a sheep raising cooperative based in the nearby village of Los Ojos, focused additional attention on the issue of contemporary land use, by moving their flock of nearly 2,000 sheep into a state owned wilderness area located about ten miles west of Tierra Amarilla. Ganados is a group of local sheep owners who cooperatively graze their flocks, own and operate a weaving co-op, and a retail outlet for their mutton and wool. Their occupation of the wilderness area was calculated to draw attention to their ongoing struggle to obtain desperately needed grazing land for their sheep.

Ganados did not characterize their actions as a land grant issue. However, many residents of the region quickly noted that the wilderness land in question had been carved from common lands on which their grandfathers had pastured their own flocks in the not so distant past. Many murmured that it was about time local residents got some benefit from land they felt was being reserved to graze elk and other wildlife for the recreational use of non-resident hunters.

Amador Flores' defiance brought attention to how the adjudication of land grants effected on individual. Ganados' actions, on the other hand, pointed out the effects which the privatation of common lands had on the communities which depended on them for their livelihood. With no control over their own resources, many residents of land grant communities have been forced to leave in search of employment. Many who remain, depend on the menial jobs offered by the ranchers who now own the lands, and the recreation and leisure industries which promote the region as a tourist mecca; or the government, which also owns much of the surrounding land.

This symposium will address many scientific issues related to how our respective governments hope to sustain the productivity of our timber and grazing resources. My brief presentation provided only a brief glimpse at some of the human issues which have been impacted by previous actions and policy. I hope we look at our past with some expectation of learning form our experiences. As we look at the legacies of our past land and water policies, it may be wise to remember the advise that Niccolo Machiavelli gave his prince more than 500 years ago:

> *... above all things, abstain from taking people's property, for men will sooner forget the death of their fathers that the loss of the patrimony.*

The ability of our planet to sustain its inhabitants is the ultimate patrimony which we can pass on to our children. With that in mind, I wish this symposium, and each of you individually, success in your efforts to achieve that end.

HISTORIA SOBRE EL CAMBIO DEL USO DEL SUELO EN MEXICO

Hugo Manzanilla Bolio[1]

El proceso del desarrollo histórico del hombre se asocia con el destino de los lugares en donde se han asentado, las viejas tribus nómadas que recorrieron por milenios la superficie de la tierra apenas si dejaron huellas de su tránsito; pero cuando decidieron establecerse en las orillas de los ríos, que aseguraban el abastecimiento permanente de agua, fué cuando empezaron realmente a forjar la historia de sus pueblos. Pero también con ello se empezó a construir otra historia; la del uso de la tierra para un fin específico, que impidiera a las grandes hordas humanas deambular de un lugar a otro: Junto con ello empezó a generarse el conflicto de la posesión de la tierra.

Con la práctica del nomadismo, empezó el cambio en la utilización de los recursos naturales para beneficio del hombre. Aquí se inicia realmente la controversia que aún no termina, por que no estamos totalmente convencidos de que estos cambios, impuestos por la necesidad de proveer mayores satisfactores al hombre hayan sido los más adecuados y los más convenientes.

En el caso particular de México, los viejos códices señalan que en los feudos de los señores principales, de las tribus que habitaron las áreas de mayor potencialidad productiva se estableció el principio de dominio sobre lo mejores lugares, que ya es un símbolo de evolución en la posesión de la tierra para fines específicos.

Como es lógico, requerían para poder utilizar al máximo sus tierras, la mano de obra y el apoyo de la gran masa de población que constituía estas comunidades.

En el México de los Aztecas, el Calpulli, que no es sino la propiedad comunal, alimentaba a los súbditos del inmenso imperio, pero se reservaban las mejores áreas como la propiedad de la clase sacerdotal y de la clase dominante, que los súbditos debían trabajar en beneficio de las élites en el poder.

Durante la época de la Colonia, la velocidad del deterioro en los recursos naturales alcanzó niveles dramáticos. Apenas habían transcurrido 40 años de la llegada de los conquistadores cuando ya la propia corona española buscaba la manera de evitar el alto grado de agotamiento que estaban realizando los colonizadores . Por ello, en 1533 expide las famosas Leyes de Indias, que contenían entre los conceptos importantes la protección de la vida de los propios indígenas, que estaban siendo mermados en su población en forma vertiginosa, tanto por la cantidad y dureza del trabajo como por las enfermedades traídas por los conquistadores; así mismo, se consideraba la necesaria protección de los bosques y arboledas que eran derribadas e incendiadas para establecer cultivos agrícolas y lugares de pastoreo para el ganado que traían del viejo mundo.

Las provincias que comprendían la Colonia fueron expidiendo, a la vez, leyes tendientes a proteger las tierras y bosques de común repartimiento; o sea, los que correspondían al anterior concepto del Calpulli Azteca.

No obstante lo arriba señalado, se fué restringiendo el derecho natural de los indígenas para el uso y disfrute de los recursos que la naturaleza les había proveído, empezando así el acaparamiento de grandes extensiones de tierras en manos de unos cuantos que tenían el poder y los medios económicos.

El papel que el hombre ha jugado en relación con los recursos naturales y en particular con los forestales, no siempre ha sido el mismo, en un principio, el hombre fué un simple espectador de lo que ocurría en la naturaleza, vivía de lo que ella le podía proporcionar, se alimentaba de los productos que obtenía en forma natural de los recursos, muy especialmente de los bosques.

Al multiplicarse, aumentaron sus necesidades y al crecer su población, empezó a perturbar los ecosistemas naturales convirtiéndolos en superficies de cultivos agropecuarios. Paradójicamente, para subsistir tenía que alterar y muchas veces destruir lo que hasta entonces le había permitido mantenerse: los bosques, selvas y matorrales.

Con el desarrollo de las sociedades y sus economías, el hombre aprendió a domesticar un número mayor de especies animales y vegetales dando origen al llamado sistema tradicional o familiar de producción agropecuaria y forestal, así, en cada país, de acuerdo a sus características, y a partir de este sistema tradicional, generó su desarrollo tecnológico.

El incremento de la economía, el comercio, la industrialización y sobretodo, con la aparición de los grandes centros de población, se generó una sociedad que en la actualidad solo participa parcialmente en forma directa en la producción primaria ya que el resto se dedica a otras actividades cuyas utilidades le permiten adquirir los

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productos que se requiere. Las características anteriores dan origen al desarrollo de los sistemas comerciales y empresariales de producción agropecuaria y forestal, así como a tres grandes contradicciones que se presentan en toda sociedad en crecimiento.

La primera contradicción se presenta entre el productor y el consumidor, cuando este último reclama más producto por su dinero en tanto que el productor, demanda más dinero por su producto.

La segunda, ocurre entre el productor y los recursos naturales, puesto que aquel altera el medio natural en sus afán de maximizar los productos extraídos a partir de los recursos: agua, suelo y biota; en tanto que el medio natural precisa, que parte del trabajo sea dirigido a aumentar sus condiciones para mantener sus integridad para minimizar su alteración y deterioro.

La tercera, se da entre la sociedad y los recursos naturales, en virtud de que con el crecimiento de la población, se demandan más productos originados de los recursos naturales, fenómeno que propicia un mayor grado de desorden, que seguramente conducirá con el tiempo a una disminución de la producción; simultaneamente esta sociedad reclama la conservación del ecosistema, entrando en un círculo vicioso que genera un demerito en la calidad del medio ambiente y el nivel de vida de productores y consumidores.

En suma, los productores tradicionales al verse forzados, han tenido que aplicar tecnologías en condiciones inapropiadas, incrementándose los daños permanentes sobre los recursos naturales.

Las contradicciones de una sociedad en desarrollo, han orillado a que un gran número de productores marginados, realicen sus actividades en áreas que por sus características, no son adecuadas para la actividad que efectúan, dando como resultado el incremento de la deforestación, la erosión del suelo, los acarreos de tierra que producen azolves que acortan la vida útil de las presas, el aumento de los procesos de desertificación (Manzanilla 1989), la pérdida de biodiversidad, la presencia de los incendios, el calentamiento global y el deterioro del medio ambiente en lo general.

Los procesos de evolución de la sociedad mexicana, no han escapado a las contradiccciones propias de las sociedades en desarrollo. La superficie cubierta de bosques, selvas y matorrales del país, se ha visto fuertemente reducida, debido principalmente al cambio de uso del suelo para dedicarlos a la producción agrícola y ganadera, así como para dar lugar a asentamientos humanos.

Por otra parte en aras de resolver un problema actual, se esta descuidando y comprometiendo el futuro ecológico del país al cambiar el uso del suelo; transformando los lugares cubiertos con bosque por terrenos agrícolas y ganaderos, los que en muchas ocasiones, con el paso de el tiempo, se convirtierán en terrenos erosionados y en el mejor de los casos en bosques degradados, alterados, con un poco o escaso valor para la sociedad en términos de los bienes y servicios que ofrece.

Se hace necesario concientizar a los grupos que influyen en las decisiones en el sentido de que es posible manejar bosques con fines de producción, sin causar deterioro irreversible a nuestros ecosistemas forestales y aún más, de que existen técnicas que al aplicarse permitirán recuperar una buena parte de los bosques perdidos, con la ayuda de plantaciones.

Sin embargo, si las condiciones anteriores se dan, se debe tener el suficiente cuidado para no caer nuevamente en el error de "Sacar utilidad en los recursos forestales" en vez de "Emplearlos útilmente".

Es importante transmitir a la población rural y urbana el concepto correcto de lo que debe ser una cultura forestal, que contempla el conocimiento de los procesos que ocurren en la naturaleza, con el fin de poder inducirlos por medio de la técnica para así ordenar en el tiempo y el espacio los aprovechamientos forestales que proprocionarán los bienes y servicios que demanda la sociedad bajo el principio de rendimiento sostenible.

Es necesario delimitar el uso del suelo del territorio mexicano y definir aquellos lugares que sean apropiados para los ecosistemas forestales clasificados por su uso potencial y por la finalidad que le pretenda dar como :

- Areas de recreación (parques)
- Areas de conservación (santuarios, reservas).
- Areas de protección (cuencas, bordos de presa)
- Areas de producción extensiva
- Areas de producción intensiva

Favorecer y apoyar las tecnologias para el uso integrado de los ecosistemas forestales, bajo las premisas del desarrollo sostenible con el fin de que se asegure que los bienes y servicios que proporcionan sean aprovechados por la sociedad en forma contínua.

Es necesario involucrar a los propietarios de los recursos forestales y al público en general en la conservación de los ecosistemas realizando las recomendaciones de los técnicos, que hoy por hoy no respetan por no sentirlas suyas.

Afortunadamente cada día la población, está adquiriendo conciencia de que con los avances de la investigación y la tecnología sobre ecosistemas se hace más factible su manejo, por lo que se debe incrementar el apoyo a la investigación, bajo el principio del desarrollo sotenible, así como los mecanismos de validación transferencia y adopción de tecnologías.

Heinrich Cotta, el famoso silvicultor Alemán del siglo pasado decía "El buen técnico forestal obtiene los mayores rendimientos del bosque sin deteriorar el suelo, pero el malo no puede obtener estos rendimientos ni preservar la fertilidad del suelo".

Es preciso encontrar respuestas viables, que se sustenten en un análisis integrado de los aspectos políticos, socio económicos, científicos, ecológicos y tecnológicos para conciliar los aprovechamientos forestales con el impacto

ambiental que causan, puesto que resolver exclusivamente una faceta del problema ecológico o social, no conduciría a la solución del conflicto.

Sin embargo, difícilmente lo vamos a conseguir, si los que somos consumidores, especialmente si los que vivimos en la comunidad de las ciudades no los entendemos, y aceptamos que si queremos productos sin menoscabo de la calidad de los ecosistemas forestales y consecuentemente de nuestro entorno, debemos pagar un precio justo por ellos y compartir la carga que esto representa.

Quiero hacer mención ahora, a lo que en 1990, en la reunión sobre "Manejo de Cuencas para Uso Múltiple" celebrada en Morelia; Michoacán, dijo nuestro muy estimable amigo y colega, Sotero Muñiz, Miembro retirado del Servicio Forestal de los Estados Unidos en su presentación de apertura de dicha reunión, cuando señaló los siete puntos claves, que debían considerar los participantes para entender que es lo que estaba haciendo el grupo y dónde quería ir. En términos muy precisos Sotero nos estableció un marco de referencia que fué de gran utilidad en las reuniones posteriores y que permitió hacer una ordenada suma de conclusiones; entre las cosas más importantes que señaló a las tendencias en el uso de los recursos naturales en los últimos 50 años y sus proyeciones a los proximos 20 años, Sotero decía, ¿ Como será la calidad del aire y agua en el año 2010 ?; ¿Tendremos más o menos áreas forestales?; ¿Aumentará o disminuira la productividad de las tierras cultivadas?; ¿Las poblaciones de fauna silvestre y de peces crecerán o disminuirán ?; ¿ Que tanto avanzará la erosión del suelo ?; ¿ Continuaremos perdiendo especies amenazadas de flora y fauna ?.

A estas interrogantes se tiene que aceptar, concluía nuestro amigo, que la tendencia es negativa y que refleja con mucha aproximación lo que pasará, si continuamos como hasta la fecha. Al mismo tiempo, nos indica, que esa tendencia puede revertirse, pero que demanda una suma de esfuerzos de todos los involucrados con los recursos naturales; desde las decisiones políticas de los gobiernos a nivel mundial, hasta los que están utilizando la más pequeña superficie de tierra para vivir de ella.

Nosotros coincidimos con este punto de vista, sólo que habremos de agregar que cada día que pase el esfuerzo que se requerirá para cambiar esa tendencia negativa, deberá ser cada vez más grande.

Para los estudiosos del cambio del uso del suelo no es secreto que, año con año, 17 millones de hectáreas Forestales son deforestadas y modifican radicalmente su esquema natural; principalmente en las zonas tropicales del mundo; este es un ritmo que no podrá soportarse por mucho tiempo.

México no escapa a este fenómeno en sus áreas tropicales; la vertiginosa transformación a áreas agrícolas y a zonas de pastoreo ha cambiado a las selvas en los últimos 30 años; en este tiempo se han ensayado desde los programas de colonización hasta la creación de ejidos en gran escala, donde la población tiene crecientes y diarias necesidades de alimentación; granos y carne de animales domésticos, que sólo pueden darse sustituyendo la selva por áreas de cultivo.

Las experiencias y los resultados no están siendo como se pensaba; los bajos rendimientos por hectárea y el crecimiento continuo de la población son factores que van en contra de la permanencia de las pocas áreas arboladas que aún quedan en las zonas tropicales del país.

En las zonas de bosque y de vegetación de zonas áridas se presenta un efecto semejante, pero no tan drástico, en estas áreas la población es menor, se encuentra más dispersa y tiene otras alternativas económicas, pero no deja de ser grave el impacto sobre los recursos naturales.

Actualmente se emprenden programas de apoyo a las zonas rurales; se expiden leyes para la organización productiva de los campesinos; se realizan campañas para la concientización del uso racional de los recursos naturales; pero sentimos que hacen falta muchas cosas más, para poder lograr el bienestar de los 80 millones de habitantes del país; que además, tienen el compromiso de dejarlo en mejores condiciones para las generaciones del porvenir.

Finalmente considero, que ésta es la situación por la que están pasando todos los países en vías de desarrollo, pero también debo considerar que los recursos naturales, como ya se ha mencionado en múltiples foros corresponden a la humanidad, por lo tanto será el esfuerzo organizado el que vaya cumpliendo el anhelo del uso racional y de la planeación futura en el destino de los suelos. En este empeño los forestales del mundo estamos más comprometidos que nadie, hay mucho trabajo por hacer ahora y seguramente habrá más para los futuros colegas.

MENSAJE INSTITUCIONAL EN LA SESION DE CLAUSURA

Hugo Manzanilla Bolio[1]

Deseo expresar mi agradecimiento a los colegas del servicio Forestal de los Estados Unidos, quienes han sido unos excelentes anfitriones., que nos dieron la oportunidad de saludar a nuestros viejos amigos y que a la vez nos brindaron la oportunidad de conocer a otros nuevos .

Considero que esta reunión ha sido muy productiva ya que siempre hay oportunidad de aprender más y aunque se ha avanzado,todavía queda un largo camino por recorrer. Es importante saber que no hay tiempo que perder porque el futuro se inicia el día de hoy fue el futuro de ayer.

han sido muy satisfactorio constatar que se trabaja conjuntamente en temas comunes, y es por ello que el tema SOSTENIBILIDAD nos une a pesar de las diferencias geofísicas y culturales. Compartimos la misma preocupación por dejar un mejor mundo a las futuras generaciones, y eso se noto puesto que cada vez es más frecuente escuchar trabajos conjuntos, que es lo que en realidad se busca en estos eventos. Medio mucho gusto ver trabajos con autores de México y de los Estados Unidos; como ejemplo las interesante sesión de Posters. Ojalá que en la futuras reuniones se mantuviera esa característica, para que el esfuerzo realizado sea fructifero.

Ayer se reunió el comite para discutir acerca del futuro de estas reuniones y se decidió que deberían continuar, tomando el acuerdo que el próximo Simposium se realizará durante 1 mes de Julio de 1994, en Guadalajara, Jal., México.

Se estableció que el tema del evento se deberá trasmitir la vinculación que existe entre la investigación y la operación en su concepto más amplio, contempla a la operación en relación con los productores.

Se ha optado por Guadalajara, Jal., para aprovechar y transmitir las experiencias que se tiene en Tapalpa, que es un área demostrativa del INIFAP con productores, involucrando a técnicos y dueños de los bosques, así como autoridades estatales y federales, lo mejor de este proyecto es que actualmente es autosuficiente; Allá los esperamos.

Deseo nuevamente agradecer a todos ustedes su hospitalidad, ya que nos han hecho sentir como si realmente estuviéramos en nuestra casa.

Esperamos atenderlos de igual manera durante su próxima estancia en México.

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Economic, Social, and Ecological Indices for Natural Resource Sustainability Evaluation

Deborah J. Shields[1], Brian Kent[2], Gregory Alward[3], and Carlos Gonzalez-Vicente[4]

Abstract.—There is increasingly an understanding of the need to sustain ecosystems. However, the meaning of sustainability, the importance of linkages between ecosystem health and rural community viability, and the appropriate uses for natural areas, particularly those held in public trust, have all led to conflict over land management decisions. In this paper, definitions of sustainability and a brief history of the conflicts over management of U.S. National Forest System lands are presented. These serve as background for a decision support system (DSS) intended to facilitate the analysis of joint ecosystem-community sustainability. Finally, a matrix of indices of sustainability derived from the data and tools in the DSS is introduced.

INTRODUCTION

We human beings are the only species capable of a world view, capable of seeing beyond our personal circumstances and needs to the consequences of our actions. That capacity is manifested in our increasing awareness of environmental issues. As we learn more about physical and biological systems, we are becoming more sensitive to the impacts that human activities have on the environment. There is growing concern that our impacts are too great; that actions by our species are altering natural systems in perhaps irreversible ways. If this is so on a broad enough scale, the potential for global biophysical change could be enormous.

One response to this information is a shift in world view from anthropocentric to more biocentric, from viewing humans as controlling nature to including humans as a part of nature. There is increasingly a belief that humans should act in ways that allow ecosystems to maintain themselves, to be sustainable. Beyond any environmental ethic, such behavior is enlightened self interest since natural systems provide irreplaceable life support services.

But the problem is not simply one of preserving natural systems. Humans have developed complex cultural, institutional, and economic structures. There is as great a need for these social systems to be viable as there is for biological systems to be healthy. Exclusive focus on either is both inappropriate and impossible.

Particularly in rural areas, the linkages between community economic and social structures and the surrounding environment tend to be direct. A major portion of the local economy is often based upon resource production from ecosystems: crops from agricultural lands; timber, minerals and recreation from semi-natural lands; and aesthetics and preservation from natural ecosystems. If output of these resources cannot be sustained, jobs and income are lost and the community social and institutional structures are negatively impacted. Unfortunately, our understanding of sustainable extraction of resources is limited.

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Furthermore, commodity extractors, recreators, preservationists, and business interests each have opinions about the appropriate uses of natural and semi-natural ecosystems, which reflect their differing belief sets. Since not all uses are compatible, conflict is almost inevitable. This is particularly true for, but not limited to, publicly managed lands such as the U.S. National Forest System. In response, the U.S. Forest Service is shifting to an ecosystem management paradigm, one tenet of which is to within the sustainable capacity of the land, meet the needs of people who depend upon natural resources for food, fuel, shelter, livelihood, and inspirational experiences. This will be a complex and challenging task that will require indicators of ecosystem and community status, projections of future states, tools for analyzing tradeoffs, and a way of organizing and interrelating these data.

In this paper, we propose a decision support system to facilitate the analysis of joint community-ecosystem sustainability. The system comprises a set of modules that link data to interpretive, analytical, and decision making tools. The following sections we will review some core concepts of sustainability, present background on the current conflicts over public land management and introduce the decision system framework. Thereafter we will concentrate on indices of community and ecosystem sustainability that could be derived from the data and analytical tools.

In closing this section we note that while we focus on the U.S. Forest Service case, conflict over the use and exploitation of ecosystems exist world-wide (Gore 1992). Environmental conservation, the rational use and conservation of natural resources, as well as the sustainability of the production of goods and services, constitute the critical challenge of the international agenda in the '90's, and certainly will continue to be an increasing worry in the next decades. Our planet is confronting a crisis of survival and every day it is more obvious that environmental problems affect all of humanity, without distinguishing borders, races, ideologies, or social conditions.

In particular, for developing countries like Mexico, which are confronting the challenge of developing themselves and at the same time reversing the process of natural resource destruction, requires of everyone talent, determination, and cooperation in order to define the best opportunities that permit sustainable development.

Current conditions require a truly new type of cooperation in order to confront the problems of international development such as foreign debt, illegal immigration, [international] relations in terms of trade and protectionism, as well as threats to the environment such as erosion, urbanization, pollution of the air, soil, and water, loss of biodiversity, climatic change, destruction of the ozone, and the inadequate management of toxic waste. The Forest Service experience differs in detail from other cases; however, the lessons learned should be fairly robust, with applicability elsewhere in the world including in Mexico.

DEFINITIONS OF SUSTAINABILITY

An exhaustive review of the literature of sustainability is beyond the scope of this paper. Rather, the purpose here is to introduce the idea of sustainability, considering a few alternative definitions for the term. These definitions are not necessarily in conflict. They simply reflect the intellectual orientation of the authors, be that economic, biophysical or community development. Each definition presumes that sustainable systems have identifiable characteristics. In a later section we will be discussing indicators of sustainability. Indices are intended to provide information about the current state of a social or biophysical system, about whether it exhibits the characteristics of a sustainable system. As such, they can be useful for tracking the state and trend of these systems and the effects of policies directed toward them.

The Biophysical Perspective

To sustain something is to keep it in existence, to preserve, continue or maintain it. From the biological perspective, the goal of sustainability is to maintain the integrity of biological systems. Disagreement arises over where to place emphasis, on species or on ecosystems. This is partly due to differing perspectives on natural systems. In an upward causation view of the environment, each species is the endpoint of an historical line of development (Rolston 1988). Its genetic information embodies all the learning and adaption undertaken by its evolutionary predecessors. Thus loss of a species is the irrevocable termination of a lengthy process. Sustaining individual species, the goal of the Endangered Species Act of 1973, reflects the view that it is inappropriate for humans to cause such terminations.

In the context of downward causation, species are seen as parts of a system. Their genetic information reflects both history and place. Species develop their specific characteristics so as to survive in the ecosystem where they live. Thus their existence is just as threatened if the system for which they are specifically tailored ceases to exist as if their numbers are drastically reduced. This latter view is reflected in ecosystem management's call for sustaining soils, air, water, biological diversity, and ecological processes, in other words all the components of a multi-dimensional system.

However, sustaining ecosystems does not necessarily imply maintenance in the present state. This is just as well, as to do so would be to accept the present state as optimal, which may or may not be the case. Most natural systems are complex and dynamic, rather than simple and static. They are largely self regulating (a talent humans have yet to acquire) and are capable of recovering from exogenous shocks. They also cycle and adapt to changing circumstances, evolving over time to new states. Often such systems are said to exhibit dynamic disequilibrium (Potvin 1991). In this context, biophysical systems are sustainable, i.e., maintain their integrity, if they have not been so impacted as to be unable to withstand shocks and regenerate themselves.

The Economic Perspective

An alternative view of sustainability derives from economics and capital theory. The goal from the economic perspective is to maintain income. Hicks (1946) defined income as "the maximum value [we] can consume during each week and still expect to be as well off at the end of the week as [we were] at the beginning." This is accomplished by living off the interest earned by capital rather than off the capital itself. The stock of capital is kept in tact.

Disagreement arises over the definition of capital stock and the appropriateness of assuming substitutability between manufactured and natural capital. When renewable and nonrenewable resources are viewed as individual commodities, natural capital stock can be represented by the amounts available for productive processes. If the same quantity of output can be produced with fewer resource inputs in the presence of more efficient capital, then manufactured capital is said to have been substituted for natural capital. It has been argued that through human ingenuity, expressed as technical innovation, we will always be able to find substitutes for depleting natural capital (Solow 1986).

If this is so, a system can be sustainable as long as adequate investments are made in manufactured capital to replace depleting natural capital. Returns from resource extraction, in excess of cost, should be invested in another form of reproducible capital asset. If such reinvestments are made, constant consumption, or increasing consumption in the presence of technological innovation, is theoretically possible (Hartwick 1989).

If renewable and nonrenewable resources are viewed as integral parts of a biophysical system, then the magnitude of natural capital is determined by the health and geographic extent of natural systems. These systems provide life support, waste disposal and amenity services that no amount of manufactured capital can replace. The returns which we wish to maintain at current or higher levels include these services, along with the outputs generated by manufacturing processes.

The previous view of infinite substitutability is here replaced by strong versus weak marginal substitutability between specific environmental factors and manufactured capital (Mäler 1989). This view reflects that fact that within relevant time frames there are absolute limits to depletable resources, strict limits on sustainable rates of flow of renewables, and no replacements for some environmental features. From this perspective, natural and manufactured capital are considered complements rather than substitutes (Gross and Veendorp 1990).

The Sustainable Development Perspective

The Bruntland Commission Report, "Our Common Future," (WCED 1987) defined sustainable development as creating consumption possibilities for the present, without compromising the ability of future generations to meet at least a similar quality of consumption. Sustainable development should be distinguished from sustainable growth. Although the term development implies increasing incomes, perpetual growth in income for everyone worldwide is impossible given finite resources. Alternatively, sustainable development can be thought of as improvement in the quality of life without the necessity of increasing per capita resource use. This maintenance of quality implies protection of natural systems, as well as structural changes over time. And so, some things must change while others are held constant. Natural systems are utilized to generate incomes, which are sustained by investing some portion of profits into other productive activities, including maintaining the integrity of natural systems (Costanza and Daly 1990).

Successful implementation of such a proactive agenda will be extremely challenging, particularly in the face of ever increasing population and demands on natural systems. Ecosystem management is one possible approach. The biophysical factors of system sustainability (soils, organisms, climate, water, and energy) are considered together with the socio-cultural factors (economic, behavioral, cultural, institutional and political) with the goal of joint ecosystem-community sustainability. In the next section of this paper we examine how alternative world views have led to conflict over land management.

SOURCES OF CONFLICT

A complete characterization of the sources of conflict that impact the management of national forests in the United States is complex and beyond the scope of this paper. We focus on a brief overview here. For a comprehensive description of the evolution of conflicts over the

management of USFS lands see Wondolleck (1988). A detailed presentation of the legal aspects of these conflicts, particularly as they apply to land management planning is given in Wilkinson and Anderson (1987). Both of these works provide important insights into the history and evolution of conflicts over national forest uses. It is obvious from the pictures painted in them that these conflicts are nothing new and in fact, in their early manifestations led to the creation of the Forest Service as an agency.

By the late 1800's it became increasingly clear to many that uncontrolled exploitation of public domain wildlands and their resources was leading to their inevitable demise. The greatest concerns were expressed by two groups; preservationists who generally viewed development on public lands as undesirable, and conservationists who favored:

> *"rational planning to promote efficient development and use of all natural resources (Hays 1959)".*

Another important component of the conservationist movement was it's grounding in rigorous professionalism and scientific management. Due to many factors, not the least of which were the involvement of men like Gifford Pinchat and Theodore Roosevelt, the conservationist paradigm provided the cornerstone of the management philosophy of the Forest Service (Wondolleck 1988). From 1905 when the agency was established until after World War II, this paradigm served the agency well and for the most part, satisfied preservationists (for some important exceptions to this, see Chapter 2 of Wondolleck 1988).

However, after the war, things changed rapidly as a result of several major factors. Demands for "commercial resources" such as timber and minerals increased dramatically. At the same time, the list of legitimate "noncommercial" uses such as wilderness preservation and recreation, for which demand existed, expanded greatly. The dichotomy between conservationists and preservationists became more clearly defined, with the former advocating commercial uses and professional/scientific management and the latter advocating noncommercial and preservation values (Wondolleck 1988). Congress also played a major role by passing a series of laws beginning with the Multiple-Use-Sustained-Yield Act in 1960 and ending with the National Forest Management Act in 1976. Finally, the Forest Service, has always been strongly linked to the conservationist school of thought and this has strongly influenced it's approach to the growing controversies over the uses of the national forests.

So where has all of this led in terms of major controversies today? Wilkinson and Anderson (1987) offered a short list of important problems that still seem relevant today:

i) below-cost timber sales and roads,

ii) water quality standards,

iii) old growth forests, biological diversity and spotted owls,

iv) energy and mineral leasing, and

v) national forest planning.

Clearly, many others could be added to this list, but these five are representative.

Wondolleck (1988) suggests that despite all the best efforts of the major players such as the Forest Service, interest groups and congress, conflicts have been increasingly difficult to resolve. She explains in detail why she believes this to be the case and outlines a new approach for resolving management disputes on national forests. She identifies five factors that are key ingredients to such an approach:

i) building trust,

ii) building understanding,

iii) incorporating conflicting values,

iv) providing opportunities for joint fact finding, and

v) encouraging cooperation and collaboration.

Finally she suggests that forest planning as mandated by the NFMA provides a framework within which this approach to conflict resolutions could be implemented.

One way of characterizing much of the conflict over national forest management is to characterize it as Normative (as opposed to Positive) Disagreement. That is, people or groups of people (including agencies or other organizations) hold alternative belief systems and different goal sets. In the scenario for national forest management, an example of this is the dichotomy between conservationists (as represented by the Forest Service) and preservationists (as represented by environmentalists). Add in the disparate requirements of the laws passed by Congress and it is easy to see why it is so difficult to make viable decisions about national forest management within the Forest Service. Figure 1 illustrates the mix of positive (science) and normative (beliefs) that may be present in natural resource management conflicts.

One response to this within the Forest Service has been the development of a new paradigm for forest management known as ecosystem management. This new approach is rapidly evolving and when more fully developed, will represent a comprehensive change in the way in which the agency does business including forest planning. In terms of conflict resolution, the factors identified by Wondolleck (1988) are quite consistent with approaches envisioned within the

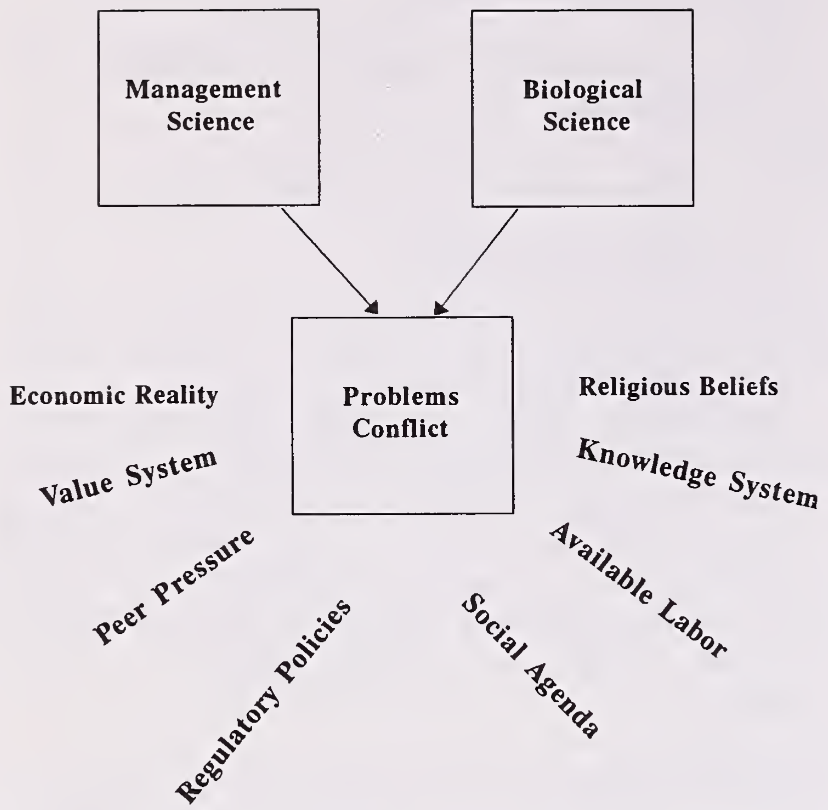

Figure 1.—One view of conflict in natural resource management.

ecosystem management paradigm. Another fundamental component of the new approach is the idea that all management must be constrained by requirements for sustaining and preserving ecosystems—a concept that has long been key in the thinking and beliefs of preservationists. At the same time, the Forest Service is still under a legal mandate to manage for multiple use.

Resolving conflicts about land management within the context of ecosystem management will still require the use of a variety of quantitative and economic techniques to provide supporting information and to conduct tradeoff analyses. In the remainder of the paper we briefly sketch out an organization for a system to facilitate this work. We also offer suggestions on the definition of indices to better define sustainability, a key component of the ecosystem management approach.

DECISION SUPPORT SYSTEM STRUCTURE

Even though ecosystem management represents a new paradigm for the operation of the Forest Service, the need to conduct analysis in support of decision making remains. That is, while a key component of ecosystem analysis is participatory decision making with each stake-holder having equal representation in the process, considerable information needs to be obtained, managed and analyzed in order to provide a background context for decision making. In this section we briefly describe a system structure for an ecosystem management based (DSS) decision support system.

Figure 2 shows an organization of such a system with major components identified within boxes and information flows or linkages identified by arrows. Within each box, the type of function is briefly identified and in some boxes, examples of activities that correspond to the function are identified with a bar (-) preceding the activity name. In no case is any analytical tool identified—the purpose here is to suggest types of functions that might be part of a DSS for ecosystem management. In some cases, examples of tools exist that could accomplish the indicated activity, in other cases, they would need to be developed.

To relate this back to the U.S. Forest Service case, consider the idea of an ecosystem management approach to national forest planning as mandated by NFMA. The system design in figure 2 suggests a closed loop feedback approach which lends itself well to the idea of revising plans every 10 years and using annual monitoring activities to assess the need to revise (or amend) the plan in a temporally continuous fashion.

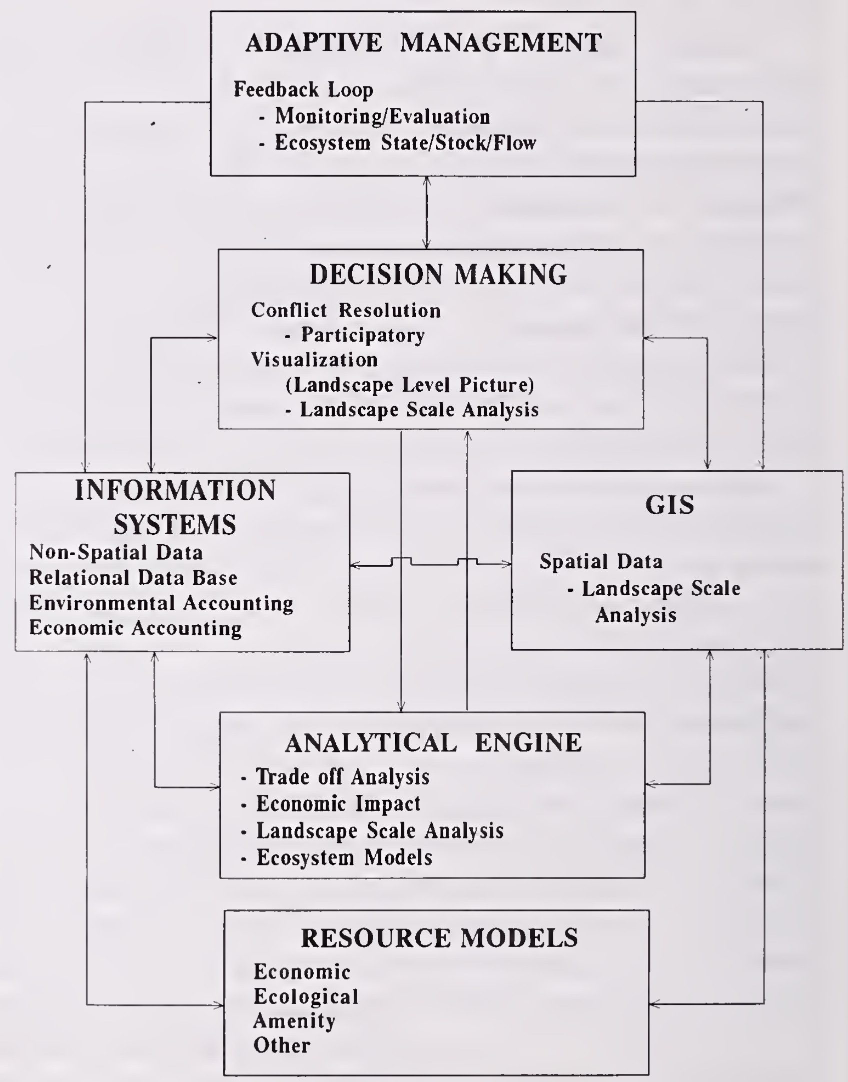

Figure 2.—System diagram for an ecosystem management based decision support system.

Decision making (in this case the formulation, evaluation and selection of alternatives is a shared process along the lines suggested by Wondolleck (1988). The information (spatial and non-spatial) and various computer tools are all used to provide information the involved parties can use to facilitate decision making. It is important to

emphasize here that the tools do not make decisions, they only facilitate the process by providing information to those that do. Once the decision is made (in this example, the selection of a preferred forest plan alternative), the adaptive management function is utilized evaluate ecosystem health, plan implementation results, etc., with an eye towards the need to amend or revise the forest plan.

In the next section we turn our attention to consideration of indices for sustainability.

INDICES OF SUSTAINABILITY

Indices, whether biological or social, are gauges of position, measures of the condition of a system. They are not absolute measures, but rather are some type of variable that can take a range of values. Typically, they are normalized to facilitate comparison. Indices should be internally consistent, but are not necessarily comparable across groups and may not be of equal weight or value.

Indices are not value free numbers that will be interpreted in the same way by everyone. They are by definition normative, presupposing an ethic and value judgements about what is important or acceptable. They are only meaningful in terms of some desired state and not all states are equally desirable to everyone. For example, one number that is often tracked as an index of economic condition is the prime rate of interest. A rate of say 6 % could be viewed as either acceptable or completely unacceptable. These differing conclusions arise because of differing economic interpretations of the index value, of what the rate means in terms of the larger economic system.

But there are often more fundamental differences of opinion. Even where individuals might agree on the consequences for the economy of a given rate, they might wholly disagree about whether that overall outcome would be "good" or "bad." Opposing views might further stem from differing individual impact. A retiree might acknowledge business' need for access to low cost capital and yet oppose low interest rates because of their adverse effect on his interest income. Conversely, someone seeking a home mortgage would benefit from low interest rates and thus see 6 % as helpful.

As this example illustrates, indices can be useful as estimates of how close or far a system is from some prespecified state. Trend would indicate movement toward or away from that state over time. (Interpretation of trend may be contentious as well, since comparisons made with the past state as opposed to the desired future may lead to different conclusions about progress.)

Potvin (1991) has observed that to study sustainability we need to find accurate and comprehensive measures, classify information, and define ideas about capital, income, wealth, equity, and value. Integrating all these factors into clear, crisp summary indicators will be difficult, but an understanding the causal links between economic activity and ecosystems will be essential (Gross and Veendorp 1990). Moreover, the advisability of using a single or even several indices to capture all the information needed to determine the state of a system is open to debate (Solow 1993).

It would be almost impossible and fruitless to identify exhaustively each of the indicators of the development process which influence sustainability, nevertheless, derived from the principal ecological/development interrelationships discussed earlier, various indicators could be employed.

The selection [of a subset of all possible indices] should be influenced by the availability of trustworthy information with which to develop them, since one of the major limitations on such a project is the scarcity of reliable and sufficient information.

Recalling our previous discussion, system sustainability was defined in two different ways: the biophysical perspective of maintaining system integrity and the economic perspective of maintaining capital stock. Indices of both types will be necessary in assessing the state and trend of social or biophysical systems.

Choosing indices consistent with the former approach implies a shift from monitoring stocks and flows to monitoring the state of system health. If biodiversity is thought of as the fabric of ecological systems rather than as a head count, then knowledge what species are present and in what numbers can be an indicator of system health and integrity (Kessler 1993). Nonetheless, species counts, diversity indices, and estimates of relative abundance, while useful and important, will not answer many questions about ecosystem health or integrity. Community structure, energy flows, and climate patterns, among others, all are important. Scale must also be considered in selecting indicators of sustainability. A useful indicator at one scale may provide limited information about the health of a system at another scale.

The economic approach has much to offer as well, both in terms of tracking the stocks and flows of human, manufactured and natural capital (renewable and nonrenewable), and also through the linkages inherent in environmental and social accounting matrices.

We recommend a matrix of indices as illustrated in figure 3. The rows in the matrix represent the systems to be sustained. The columns represent the alternative perspectives on sustainability, system integrity and capital stock. The columns can also be thought of as representing states versus quantities. Each cell holds an index category.

If system integrity is defined as the ability to recover from shocks, then a proxy for integrity would be resilience. One Indicator of Ecosystem Resilience could be the system's resistance to pathogens, since stressed systems are more susceptible than are healthy ones. Changes in cycling could also be used as an indicator since naturally occurring cycles increase in rate and amplitude in stressed systems. Numerous Indicators of Economic and Social Resilience could also be

		PERSPECTIVE	
SYSTEM		System Integrity	Capital Stock
	Biological/Physical	Indicators of Ecosystem Resilience •Rate and magnitude of Cycling •Susceptability to catastrophic events	Indicators of Natural Capital •Biodiversity •Proven reserves of nonrenewable resources
	Social	Indicators of Community Resilience •Stability of family structure •Distribution of income	Indicators of Social Capital •Number of sectors in the economy •Workforce Skills

Figure 3.—Matrix of indicators of sustainability.

developed. These might include the stability of family structure and the distribution of income across income levels and job categories.

Taking the alternative approach will require Indicators of the quantity of Natural and Social Capital. The values will be useful in determining whether the components essential to system integrity are being maintained. Biodiversity and proven reserves of nonrenewable resources are examples of this type of indicator for biophysical systems. For social systems, indices that quantify information about the community will be needed. These might include the number of sectors in the economy or the number of children receiving vaccinations. The former would be an indicator the diversity of the economy, the latter an indicator of community health.

CONCLUSIONS

In this paper we have presented a decision support system intended to facilitate the shift to the ecosystem management paradigm. This shift will require analytical and quantitative tools, data, and understanding of the linkages between biophysical and social systems. Moreover, sustaining these systems will require knowledge of their current state, desired future states and trends. Indices of sustainability, derived from the tools and data in the DSS will assist in this effort. However, agreement regarding desired end states will not be universal. Not only is work needed in developing indices, but in the area of conflict resolution as well.

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Holistic Resource Management: A Model for Building Sustainable Landscapes

Sterling Grogan[1]

Abstract — The establishment and maintenance of sustainable landscapes, particularly where land is degraded or deteriorating, now has high priority in the U.S. as well as Mexico. To achieve sustainability, regardless of how that term is defined, the management of public and private land requires an approach that incorporates into decision-making the complex interactions of culture, economics, and ecology. Conventional land management generally focuses on the achievement of a narrowly-defined or short-term objective, usually economic or ecological, rather than on improvement and sustainability of the whole landscape. Planning and management often ignore the needs and exclude the knowledge of people living on the land, or those directly affected by a particular land use, and these stakeholders are often not effectively involved in land use decision-making. The result can be protracted conflict over management goals and priorities, which seriously jeopardizes sustainability. The author describes the Holistic Resource Management (HRM) Model, an approach to the incorporation of human values, as well as economic and ecological factors, in land use decision-making. The HRM Model's collaborative goal-setting process is described, and results from current examples of holistic management in practice are used to illustrate the contributions of this Model to the achievement of sustainable landscapes.

INTRODUCTION

One challenge that confronts people who attempt to establish and maintain sustainable landscapes is to identify a practical model to guide management, in a manner consistent with current knowledge of the complex interactions of culture, economics, and ecology. The Holistic Resource Management (HRM) Model (fig. 1) is such a model that could be useful to scientists and land managers in the U.S. as well as Mexico.

The world-wide decline of biological diversity and productivity is well established (Ehrlich and Wilson 1991, Soulé 1991). Moreover, Friend (1992) showed that most of the world's soils are, contrary to conventional wisdom, "...nonrenewable within a human lifetime." Mabbutt (1984) reported U.N. Environment Programme data showing that 40 percent of the rangelands in the United States suffer severely diminished biological productivity. Clearly, if the richest country on earth is in such condition, we need new approaches to the restoration and maintenance of truly sustainable landscapes. Conventional land management strategies may not provide what is needed to reverse land degradation and ensure sustained productivity.

For purposes of this discussion, I define as "sustainable" any approach to the management of land that: explicitly involves all stakeholders initially in setting goals for the land, and makes their involvement a key part of ongoing management; and, uses all resources in ways that do not sacrifice future productivity to achieve short-term objectives. Regardless of how the word "sustainable" is defined, without the continuing involvement of the humans who live on or are directly affected by a landscape, no effort to achieve sustainability will succeed. There are many examples, from rich and poor countries alike, that support this observation. One is the effort of IUCN, The World Conservation Union, since 1980 to create and implement "strategies for sustainability" in over 50 countries on every

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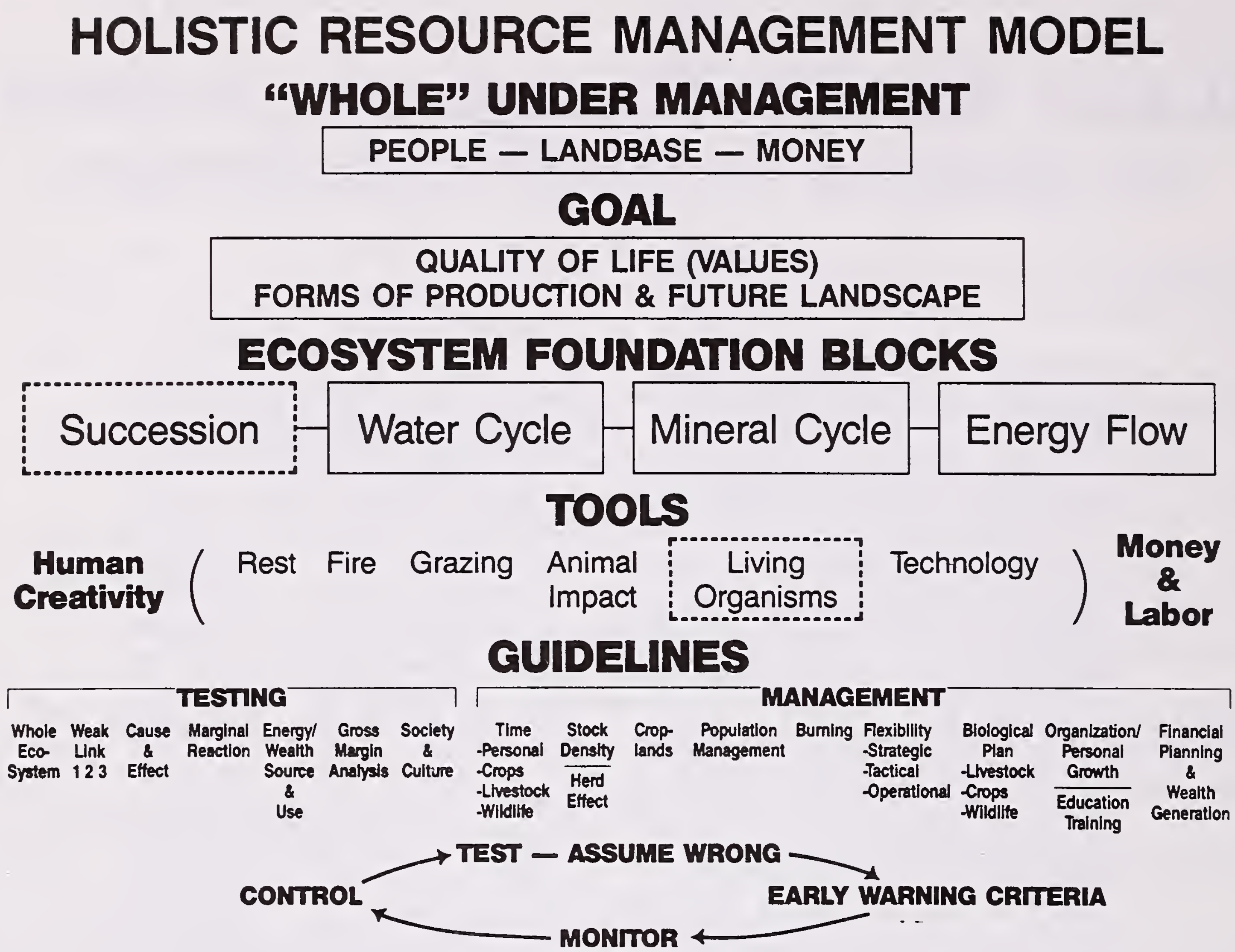

Figure 1. — The Holistic Resource Management Model.

continent. A recent review of results in Asia and Africa points out dramatically that the few cases of successful strategies are due largely to consistent, ongoing involvement of a broad spectrum of key stakeholders in the processes of development and implementation of the strategy. Where such involvement is limited or sporadic, success is not possible (IUCN 1993).

Where the HRM Model is used in North America and Africa, including my own project on the Navajo Indian Reservation in the U.S., the potential of this new model for the establishment and management of sustainable landscapes is apparent. In contrast to conventional approaches to land management, the HRM Model offers three important advantages for the manager looking for ways to make sustainability operational:

1. Human values, along with economic and ecological objectives, are explicitly included in the goal that drives management decision making, thereby meeting the need for a holistic approach to landscape management;
2. Management is directed toward the achievement of a collaborative goal, thus ensuring popular participation in management decision making, and allowing for measurement and evaluation of progress toward the goal;
3. Management is forced to be flexible, to accept the inevitability of constant change, and to incorporate consideration of an appropriate time scale in planning.

WHY DOES LAND MANAGEMENT FAIL?

While many environmental stresses contribute to land degradation, management failure is often the result of complex interactions among the following factors:

1. Conventional land managers usually focus on economic return, or on the achievement of limited objectives over a short term, rather than on the sustainability of the whole ecosystem (including humans);

2. People living on the land are not consulted in meaningful ways. Not only are their personal desires for a sustainable community not incorporated into routine management decision making, their knowledge of the land is often ignored;

3. Time is not commonly viewed as a critical variable in management. Because the recovery of biological processes following disturbance is largely a function of time (Forman and Godron 1986), time must be seen as an important variable for management;

4. Land tenure may be such that people living on the land, who have the greatest stake in land improvement, do not own or control the land;

5. Social class barriers may prevent meaningful communication between land occupants, land owners, government officials, and others interested in land improvement;

6. At the national policy level, competition for resources and attention among diverse social needs may lower the priority for sound land management.

LANDSCAPE ECOLOGY AND THE HRM MODEL

Management of a landscape for sustainability may be seen as an exercise in applied landscape ecology (Naveh and Lieberman 1984, Haber 1990). Many landscape ecologists, including Naveh and Lieberman (1984), Forman and Godron (1986), and Haber (1990), cite the need for an approach to land management that explicitly considers the complexity of interactions among many factors. The HRM Model provides such an approach. It forces the land manager to apply the concepts of landscape ecology, through focus on an explicit goal, to the management decision making process.

Landscape ecology is the science of the human ecosystem, the scientific basis for the study of landscapes of all sizes, which treats the patterns and dynamics of landscapes in cultural, as well as ecological, terms (Naveh and Liberman 1984). Thus, landscape ecology emphasizes a holistic, problem-solving approach to the concerns of foresters, farmers, ranchers, land managers and planners, geographers, and ecologists.

The Holistic Resource Management Model approaches land management from the perspective of landscape ecology, forcing management attention to the cultural values of the people in the landscape as well as the economic and ecological interactions in the landscape. The patterns and processes in a landscape are assumed to be complex and interacting in ways that may not be immediately apparent. Under the HRM Model, all management decisions are assumed to require careful monitoring, and monitoring systems are designed and installed to give managers constant feedback to detect problems at an early stage. Once a problem is detected, a solution is developed immediately, plans are reformulated and work is again focused on the goal.

Landscape ecology is cognizant of the synergy of elements in the landscape that combine to produce unknown, or unexpected, results. For example, national forest policies have important effects on decisions about land use, which in turn affect soil erosion, river water quality, sport and commercial fisheries, tourism, and retail business. The Holistic Resource Management Model forces the manager to be cognizant of the effects of decisions on the land, thereby incorporating into management the perspective of landscape ecology.

The HRM Model is a thought process model, a guide to decision making that leads the land manager to consider ecological, cultural, and economic factors in the decision making process. Decisions are directed toward the achievement of an explicit goal, arrived at through a collaborative process involving all people concerned with a particular landscape.

HRM IN PRACTICE

This paper provides a brief overview of the HRM Model, and describes one example of the use of the Model on the Navajo Indian Reservation.

I coordinate the use of the Holistic Resource Management Model at the 6,500 hectare (ha) Navajo Mine ("the Mine"), a surface coal mine in northwestern New Mexico on the Navajo Indian Reservation. To date, approximately 1000 ha of mined land is reclaimed with native grasses and shrubs, and will eventually be returned to local indigenous Navajos for livestock grazing. Mining operations will continue for many years, with land reclamation proceeding at the rate of approximately 100 ha per year, concurrent with the extraction of coal. Additional reclaimed land will become available for return to Navajos once it is determined that the land can sustain livestock grazing.

THE "WHOLE" TO BE MANAGED

Use of the HRM Model begins with the identification of the landscape of concern, the people who are a part of that landscape, and the resources (or wealth) those people bring to the management process. These three elements, land, people, and wealth, constitute the "whole" to be managed.

The "whole" at the Mine consists of five elements:

1. The Mine property and the surrounding rangeland of the Navajo Indian Reservation, approximately 15,000 ha combined;

2. The mining company, BHP Minerals International Inc.;

3. The local Navajos living around the Mine property, who will eventually receive permits from Navajo Nation government to graze their livestock on the reclaimed land;

4. Navajo Nation government natural resources agencies;

5. At least three U.S. federal government agencies with responsibilities for environmental protection and management of Indian lands.

The mining company initiated the use of the HRM Model at the Mine in 1991, to guide the process of returning reclaimed land to the Navajos. The mining company and the government agencies contribute economic and technical resources to the "whole"; local Navajos contribute their cultural and personal commitment to the land and its sustainability.

A GOAL TO GUIDE MANAGEMENT

Once the "whole" is identified, all stakeholders, including representatives of organizations and government agencies, are convened to develop a collaborative goal. This is not easy, and may take many months or years, but it is not impossible. The group tends to develop cohesion once it is apparent that there are common objectives among people who may have never before considered that possibility.

At the Mine, all of the individuals met monthly for a year, at the Mine and in Navajo community centers, to discuss long-term management of the land. Then, the group formed a detailed emerging goal by collaborative effort at one day-long meeting last January. Present at that meeting were eight people from the mining company, 13 local residents, two representatives of Tribal government, and five representatives of federal government agencies.

The goal in Holistic Resource Management has three parts, and serves to constantly remind everyone involved in management of the land what their work must accomplish. Experience shows that the goal must have three parts in order to address conflicts among people using the same resources. The three parts are:

1. The quality of life that people seek;

2. The forms of production they want on the land, to achieve their stated quality of life; and

3. Their vision of how the landscape should look in the future (50 to 100 years), in order to support their production activities.

Common ground and agreement are usually found among people of widely varying interests, once this collaborative goal is written down and discussed. From that point on, differences of opinion over production activities are more easily resolved, as people can begin discussions from the perspective of a common goal.

Goal Part 1. Quality Of Life

The personal and family values of the people dependent on the land are explicitly stated. At the Mine this part of the goal includes:

- "Meet human needs for food, shelter, and warmth;
- Maintain traditional values with freedom to adapt and change;
- Avoid conflict over land use;
- Build human relations on the basis of trust;
- Enjoy peace and quiet, pleasing landscape contours, and abundant wildlife."

Goal Part 2. Forms Of Production

These may be economic or ecological, or both. The Mine goal includes:

- "Meet regulatory requirements for vegetative cover, productivity, and diversity, and control erosion, at least cost in terms of dollars, people, and land, consistent with the entire goal;
- Produce a healthy, diverse community of wildlife;
- Produce profit from livestock, minerals, crops, tourism, and other business consistent with the entire goal."

As you can see, this part of the goal addresses legal requirements of the mining company, as well as the needs of the Navajos.

Goal Part 3. Landscape Description

Agreement is easiest on what the landscape must look like, in 50 to 100 years, in order to support the desired forms of production. People who live on the land have very clear ideas as to the desired appearance of the landscape. Example statements from the Navajo Mine goal include:

- "Return landscape to the approximate original contour with varied landscape and life forms (shrubs, trees, grasses, forbs);
- Establish effective water and nutrient cycles;
- Create a long-term management plan to guide future land improvements (water, fence, roads)."

The three-part goal should always be understood as an emerging goal, a collaborative commitment to change by all interested people. It is neither static nor comprehensive. As people and their needs change, the goal must change by means of the same collaborative effort that produced the original goal.

Thus, the HRM Model has a built-in requirement to deal with continual change.

ECOSYSTEM PROCESSES

Once the "whole" to be managed is identified, and a three-part goal is written, attention is focused on the ecosystem processes that sustain the landscape. Fundamental to the management decision-making process is a detailed understanding of the ecosystem. Management decisions must be based upon an understanding of the environment at least as comprehensive as that held by the local indigenous people.

To the extent that ecological surveys or applicable research results are available, they are incorporated into the detailed biological planning upon which daily management decisions are based under the HRM Model. The need for additional ecological research is recognized immediately in most management situations, and that need may be accommodated as part of the Model's biological monitoring program. But the lack of precise ecological data is not an acceptable excuse for poor land management.

The key ecosystem variables are:

- Plant and animal dynamics (succession);
- The hydrologic cycle;
- The nutrient cycle;

The flow of energy (or, the carbon cycle) from the sun to conversion and consuming organisms.

Every management decision must be consistent with what is known about ecosystem processes at the site. At the Mine, gaps in our knowledge are addressed through ongoing research that is funded by the mining company and carried out by university researchers, one of whom works closely with the management team.

TOOLS

In the HRM Model, a tool is anything that gives humans the ability to alter the ecosystem in order to achieve predetermined goals (Savory 1988). The Model assumes that use of any tool requires human creativity, money, and labor. All conventional land management tools are assumed to be included within the categories of **rest, fire, technology, living organisms.** Under the HRM Model, the use of any tool is assumed to be acceptable, as long as the decision to use it is consistent with the goal and the ecosystem, and the decision passes the economic, ecological, and cultural tests that are included in the Model's guidelines. The HRM Model offers two additional tools, **animal impact** and **grazing**, that are not part of conventional management strategies. Although they may sound conventional, they way they are used under the HRM Model is not conventional. One new feature of each of these tools is the focus on **time, rather than numbers of livestock,** in the management of grazing. This idea is based on the work of Voisin (1959), who showed that overgrazing is a function of the time plants are exposed to grazing animals, not the number of animals. The importance of these new tools is such that they merit more detailed explanation.

Animal impact refers to the fact that when grazing animals are tightly bunched and concentrated within a relatively small area, as they would be when threatened by predators, their hooves break and trample into the soil much of the dormant or dead vegetative matter above ground as well as litter on the soil surface. Plant material as well as dung and urine are thus incorporated into the soil. The process also breaks the crust that forms on dry-land soils between rainfall events is also broken, thereby increasing infiltration and the effectiveness of precipitation.

The key to use of the tool of animal impact is time; that is, keeping the herd on any area for only as long as it takes to thoroughly churn the soil, then moving the animals to another area. Of course, if the soil is wet, the potential for compaction dictates an even shorter time. Once the herd moves on, water, nutrients, and carbon cycle more efficiently (at rates that are, of course, dependant upon temperature, precipitation, and other factors), usually resulting in increased biological productivity. This is essentially the way wild grazing animals behaved, because the constant presence of pack-hunting predators (including humans) before the rise of livestock domestication caused bunching of herds and the resulting heavy animal impact. Now that we have removed most pack-hunting predators, the dynamics of herds grazing arid and semi-arid lands have changed, possibly accounting for much of the deterioration we see on range lands. The use of domestic livestock to achieve animal impact is one of the most innovative aspects of the HRM Model, precisely because it offers a way to restore the biological productivity of land in seasonal rainfall environments, including lands that may have been degraded by conventional grazing.

For example, at Navajo Mine, we have used animal impact twice each year for the last two years, with herds ranging in size from 55 head of cattle up to 600 head of

sheep and goats, on four plots of reclaimed, as well as unmined, land. Each plot is 0.6 acre in size, and the herd is normally left on a plot for 24 hours. We have done this for one primary reason: to show that very heavy animal impact can be managed so as to not only prevent damage to land, but also can reinvigorate vegetation. Our preliminary results show that reclaimed mined land can recover from such impact.

Under the HRM Model, the tool of grazing is used to achieve some part of the collaborative goal. Grazing is only a way to achieve human goals, and seeing it in this way helps the manager to understand that the old way of doing things is not necessarily the only way of doing things. Grazing in this context means planned grazing, that is, exposure of a herd of animals to a specified area for only long enough to remove most of the above-ground green matter, but preserving the ability of the plants to recover. In the Southwestern U.S., this often means that the herd will stay in each field from 1 to three days, with up to 90 days of rest allowed before the next grazing. However, the grazing cycle is never fixed; it is determined solely by the rate of growth and condition of the plants. That is, if the plants are recovering quickly (due, perhaps, to abundant rain or other factors), or if they are growing more slowly than anticipated (due, perhaps, to unseasonably cold weather) then the rest period may be shortened or lengthened. The grazing plan is always subject to modification as the result of constant monitoring by the manager. This is what leads to the HRM Model sometimes being called "management-intensive." Actually, holistic management seems to require no more "intensive" management than was required before the "Columbus method" of grazing management came to be the accepted norm in the livestock industry, early in this century: in the Columbus method, you put the animals out in the spring, and in the fall to go out to "discover" how many animals are left.

The issue of how much rest is required for the recovery of ecosystem processes after severe disturbance is at the heart of the major debate now raging across public lands in the U.S. Some environmental groups would have most livestock removed from public lands, so as to allow the tool of rest to accomplish restoration of biological productivity on degraded range lands. However, there is no evidence that long-term rest will accomplish that restoration. The U.S. Forest Service, along with many other agencies, has many long-term livestock exclosures in the West. Most of them show what can be dramatically seen at Chaco Canyon National Historical Park in northwest New Mexico: That 50 years of exclusion of livestock does not, in and of itself, result in the restoration of biological productivity in arid and semi-arid lands. This suggests the complexity of the whole debate about sustainability: some of our assumptions about ecosystem processes, and the roles of humans in ecosystems, are probably not accurate, and therefore may not support conventional strategies to achieve sustainable landscapes.

MONITORING

The Holistic Resource Management Model requires a meaningful monitoring program to measure site-specific variables that indicate progress toward the goal. Regular monitoring is absolutely essential in any land management process, but most conventional land management schemes focus primarily on economic results, or on the achievement of a limited ecological objective, such as eradication of a particular pest.

Each management decision is assumed to require constant monitoring, and the monitoring program is thus designed to identify the first indication of a problem. For example, at the Mine, we are planning for livestock production on the reclaimed land. Conventional monitoring in livestock production might include various aspects of animal performance, such as conception rates, daily weight gain, etc. In contrast, holistic management focuses on land performance, and measures vegetation yield and cost of production per hectare. Problems in these variables are usually detectable before they affect animal performance.

At the Mine, vegetative cover, productivity, and diversity are among the monitoring criteria, along with fixed-point photographs and regular visual inspections of the land. When monitoring results indicate a problem, the problem is identified, plans are modified, and corrective action is taken.

In each landscape, the goal will dictate what kind of monitoring will produce the earliest indication of a problem, thus allowing timely correction. Management plans are always assumed to be flexible, and the manager takes responsibility for changing plans immediately to correct a problem.

CONCLUSION

To make sustainability truly operational, the processes of planning and management for private as well as public land must include all stakeholders in the initial stages of setting goals as well as on a continuing basis. Local indigenous people, foresters, farmers, ranchers, community organizations, environmental groups and others must have a meaningful role in making decisions that affect the land they live on or near. Without such collaboration and participation, the best scientific solutions to the biological problems of sustainability will be able to achieve little more than temporary shifts in the general trajectory of decline that we see on so much land in North America.

The principal value of the HRM Model is that it offers land managers a framework within which to organize and accomplish the necessary collaboration and public participation, and then helps managers make land-use decisions that are culturally, economically, and ecologically sound. The Holistic Resource Management Model also offers

new insights about how to manage livestock in seasonal rainfall environments so as to rehabilitate degraded land and improve the economics and biological productivity of grazing land.

Given the concerns expressed at this symposium for the sustainability of landscapes in the U.S. and Mexico, the HRM Model merits serious consideration by land managers on both sides of the border.

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Desertification of Southwestern Rangelands and Rehabilitation Using Municipal Sewage Sludge

Richard Aguilar, Philip R. Fresquez, and Samuel R. Loftin[1]

Abstract — Over the past century livestock grazing on Southwestern rangelands has contributed to desertification. Years of livestock pressure on these semiarid rangelands has decreased annual dry matter production, decreased plant cover and soil organic matter content, and increased soil compaction and erosion potential. Accelerated erosion has led to on-site land degradation and surface water contamination due to increased stream sediment loading. Rangeland rehabilitation can employ a passive (removal of grazing pressure) or an active approach (immediate improvement of the existing condition of soil or vegetation, such as fertilization). The USDA Forest Service has conducted research on land application of municipal sewage sludge as an organic amendment to degraded rangeland for nearly a decade. A sludge application study (1985-1989) investigated the effects of different quantities of sludge on vegetative growth and plant and soil chemistry. Results showed that a one-time surface application of sewage sludge at 22.5 to 45 Mg ha^{-1} significantly increased plant production and ground cover without producing undesirable levels of potentially hazardous elements, including heavy metals, in either soils or plant tissues. Additional studies are investigating the effects of sludge on rangeland hydrology. Surface-applied sewage sludge has been shown to significantly decrease runoff on treated rangeland by increasing ground surface roughness and infiltration.

INTRODUCTION

The United Nations Conference on Desertification (UNCOD) defined this phenomenon as a diminution or the destruction of the biological potential of land to desert-like conditions (UN 1977). UNCOD's definition of desertification is based on the premise that over-exploitation of land resources results in vegetation, soil, and water degradation. Ultimately, removal of the plant cover leads to loss of soil organic matter, decreased soil fertility and structure, and increased erosion potential (El-Tayeb and Skujins 1989). According to Eckholm and Brown (1977), desertification is not synonymous with desert encroachment, wherein desert-like conditions extend irregularly over susceptible areas along the encroachment front. Desertification generally involves the gradual degradation of "patches" of rangeland and/or cropland within susceptible regions. Vast areas in all bioclimatic zones are potentially susceptible to desertification. Arid and semiarid lands with low productivity are most prone to this degradation if subjected to improper cultivation and overgrazing, particularly when aggravated by adverse climatic conditions (El-Tayeb and Skujins 1989).

Desertification also applies to the impoverishment of ecosystems within natural deserts. Sheridan (1981) reported that the Sonoran and Chihuahuan deserts of the American Southwest have become notably more barren during the past 100 years. Perennial grasses have declined while less

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desirable invader species have increased, including tamarisk *(Tamarix pentandra)*, Russian thistle *(Salsola kali)*, and native species such as broom snakeweed *(Gutierrezia sarothrae)* and burroweed *(Haplopappus tenuisectus)*. Dregne (1977) estimated that approximately 91 million hectares (approximately 10% of the U.S. landmass) within the United States had experienced severe or very severe desertification. Imprudent livestock grazing (overgrazing) has been the most formidable desertification force in the United States (Sheridan 1981).

Southwestern rangelands experienced heavy livestock grazing over the past century and this led to a substantial reduction in total plant cover and density (Dortignac and Hickey 1963). If the current degradation of Southwestern rangelands is not reversed, once productive rangelands may deteriorate to a point where they may never recover. Any successful grassland restoration in these degraded areas will require an increase in plant production, reduction in soil erosion, and ultimately, replenishment of soil organic matter. Soil organic matter, which influences virtually all aspects of soil fertility, plays a key role in inhibiting the process of desertification because it increases soil aggregate stability and resistance to erosion (Tate 1987).

What alternatives might be available to effectively deal with the continuing desertification of Southwestern rangelands? Because many of the degraded rangeland soils have been significantly depleted of organic matter, external organic matter additions may be needed to provide sufficient nutrients for successful revegetation and the establishment of a stable soil organic matter pool for supporting microorganisms (Fresquez et al. 1988). Removal of livestock grazing pressure would increase vegetative cover and plant litter additions over time, but this "passive approach" would be slow and the replenishment of diminished soil organic matter contents could take decades. Employing a management practice to immediately improve soil organic matter and vegetation (active approach) would produce more rapid results.

Municipal sewage sludge is an excellent choice as an organic soil amendment because it is readily available, contains comparably high levels of plant nutrients (particularly nitrogen and phosphorus), and has excellent soil conditioning capabilities (Glaub and Golueke 1989; Parr et al. 1989). Comparison of the mineral nutrient content of anaerobic sewage sludge to other common organic amendments (manure, straw, and woodchips) shows the nutritional value of treated municipal sludge (table 1).

Potential benefits and environmental problems associated with land application of sewage sludge have been studied in mine-land reclamation (Sopper and Kerr 1979) and in agricultural systems where sludge has been used as a soil amendment and fertilizer source (Sommers 1977). Depending upon its source, sludge contains varying concentrations of Al, B, Cd, Cu, Ni, Pb, and Zn (Sommers 1977). Ryan et al. (1982) identified cadmium as the sludge-borne metal with the greatest potential hazard when sludge is applied to land. Heavy metal movement in soils is dependent upon pH, cation exchange capacity (CEC), and organic matter content. However, metal mobility is restricted in alkaline arid and semiarid soils due to the formation of insoluble complexes formed with carbonates and phosphates (Bohn et al. 1979). Although the contamination of groundwater by nitrate generated through the decomposition of sludge and subsequent nitrification is possible, the contamination probability is very low in arid and semiarid regions because of low leaching potential. Careful site selection should alleviate any concerns of nitrate contamination of groundwater in sludge treated areas.

Table 1. — Mineral nutrient content of anaerobically treated municipal sewage sludge as compared with manure, straw and woodchips. [adapted from Fresquez et al. 1988]

	TKN[1]	P	K	Ca	Mg	Org. C	C:N	pH
	---------- (mg kg^{-1})				----------	(g kg^{-1})	ratio	
Sewage Sludge	10600	632	234	843	55	61	6	7.22
Manure	4190	1162	4279	21	17	290	69	8.57
Straw	1520	101	1123	46	16	218	143	7.95
Woodchips	520	2	121	21	6	170	327	5.74

[1] *Total nitrogen (TKN) determined by macro-Kjeldahl procedure; soil P determined from 1:5 soil-water extract; Ca, Mg, and K are water-soluble indices; organic carbon (Org C) determined by Walkey-Black method; pH determined from saturated paste.*

Approximately six million metric tons of municipal sewage sludge are produced annually in the United States (U.S. Environmental Protection Agency 1990). Disposal of this waste product has become a major problem for large metropolitan areas, particularly those along the heavily populated Eastern Seaboard. Large urban areas of the Southwest, including the city of Albuquerque, also produce sewage sludge from wastewater treatment plants and disposal remains a problem. Presently, much of Albuquerque's sewage sludge is applied and tilled into the soil on rangeland set aside specifically for this purpose. Safe and economical disposal of the sludge, not rehabilitation of the rangeland affected, is the City's primary objective. Innovative ways of beneficially using sewage sludge must be continually developed. The use of municipal sewage sludge for rehabilitating degraded rangeland represents an alternative to the mere disposal of sludge.

The benefits of municipal sewage sludge as an organic soil amendment to degraded sites are based on observations from two separate studies carried out by the USDA Forest Service on New Mexico rangeland (fig. 1).

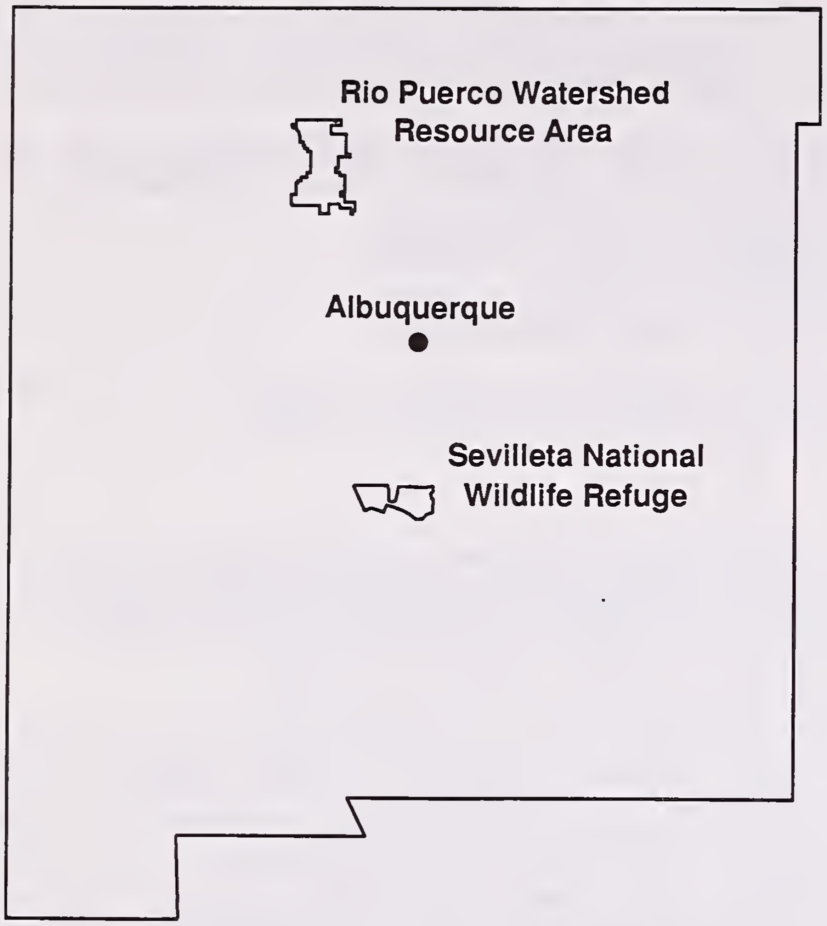

Figure 1. — Location of the two sewage sludge amendment studies on New Mexico rangeland. The Rio Puerco Watershed Resource Area (sludge application study) and the Sevilleta National Wildlife Refuge (surface hydrology study) are located approximately 100 km northwest and 120 km south of Albuquerque, respectively.

SLUDGE APPLICATION STUDY

USDA Forest Service scientists conducted the first in-depth study of the effects of sewage sludge application to degraded semiarid rangeland (Fresquez et al. 1990a, 1990b, and 1991). Dried, anaerobically digested sewage sludge from the city of Albuquerque was surface-applied to a degraded, semiarid grassland site within the Rio Puerco Watershed Resource Area (fig. 1). The Rio Puerco basin, an extremely degraded watershed with a long history of heavy livestock grazing, is one of the most eroded and overgrazed river basins in the arid West (Sheridan 1981).

Sewage sludge was applied (one-time application) at rates of 0, 22.5, 45, and 90 Mg ha^{-1} (0, 10, 20, and 40 tons $acre^{-1}$ based on oven-dried weight) to each of four plots (3 m X 20 m) in a completely randomized block design containing a total of 16 plots. The site was characterized as a *Gutierrezia sarothrae/Bouteloua gracilis-Hilaria jamesii* (broom snakeweed/blue grama-galleta) plant community on a moderately deep, medium-textured soil. The soil was classified according to Soil Taxonomy (Soil Survey Staff 1975) as a fine-loamy, mixed, mesic Ustollic Camborthid. Mean annual precipitation, measured at the site with a standard rain gauge through the duration of the study (June 1985 to September 1989), was approximately 250 mm (Fresquez et al. 1991).

Field and Laboratory Methods

The area was fenced to exclude livestock and wildlife. Pre-treatment soil samples were collected at each of the 16 plots in June 1985. Post-treatment samples were collected in August of 1985, 1986, 1987, 1988, and 1989. Plot sampling scheme, sample preparation, and handling techniques are described in Fresquez et al. (1991); chemical characteristics of the applied sludge and the soils prior to the treatment are presented in this paper. Methods employed for other soil chemical tests and plant tissue analyses for vegetation samples collected from each plot are described in Dennis and Fresquez (1989). Statistical methods employed to test for differences in soil and vegetation properties among the various sludge application treatments are described by Fresquez et al. (1991).

Results

Changes in Soil Nutrients and Heavy Metals

The addition of sludge had a tremendous impact on soil chemistry and nutrient content on treated plots. Total nitrogen (TKN), phosphorus (P), potassium (K), and electrical conductivity (EC) increased with sewage sludge application during the study's first year (table 2). Soil organic matter in mineral soil below the sludge layer did not increase until after the fifth growing season. The delayed soil organic matter response was an indirect effect of the increased nutrient availability and below-ground plant and microbial productivity in response to the sludge amendment.

Soil pH dropped from 7.8 to 7.5 in the 90 Mg ha^{-1} treatment during the first growing season, and to 7.4 in the second growing season, probably due to slightly acidic leachates from the applied sludge (Fresquez et al., 1991). Acid-producing microbial reactions in the soil (i.e., nitrification) may have contributed to the decrease in soil pH. Soil pH continued to decrease in plots with the highest sludge application through the five year study period. Metals generally become more soluble with decreased pH. Although soil pH decreased over time because of the sludge amendments, only diethylenetriaminepentaacetic acid (DTPA)-extractable soil copper (Cu) and cadmium (Cd) increased to concentrations slightly above the limits considered acceptable. Concentrations increased only after the fifth growing season; >10 to 40 mg kg^{-1} Cu and >0.1 to 1.0 mg kg^{-1} Cd are considered phytotoxic and undesirable in the soil (Tiedemann and Lopez 1982). Changes in other trace elements produced by the different sludge amendments are described in Fresquez et al. (1990b and 1991). The higher trace element concentrations resulting from the sludge amendments were probably directly related to sludge

Table 2. — Changes in soil chemical properties on plots (n = 4 per application) treated with sewage sludge, Rio Puerco Watershed Resource Area, NM. [adapted from Fresquez et al., 1991]

Sludge application (Mg ha^{-1})	Organic matter (g kg^{-1})	TKN	P	Cd	Cu	EC (dS m^{-1})	pH
		mg kg^{-1}					
			First growing season				
0	12a	729b[1]	5c	0.01a	1.04c	0.36c	7.8a
22.5	13a	817ab	15bc	0.01a	1.19bc	1.06bc	7.7ab
45.0	14a	845ab	20b	0.01a	1.60ab	1.66ab	7.6b
90.0	12a	924a	31a	0.01a	2.10a	2.23a	7.5b
			Second growing season				
0	14ab	665b	4c	0.01a	0.92b	0.37b	7.8a
22.5	15a	828ab	20bc	0.01a	2.21ab	0.96ab	7.6ab
45.0	15ab	843ab	44b	0.02a	2.99a	1.26ab	7.4b
90.0	12b	987a	72a	0.02a	3.48a	1.97a	7.4b
			Fifth growing season				
0	14b	682b	9b	0.01b	0.88b	0.40c	7.8a
22.5	18ab	890b	26ab	0.01b	2.40b	0.66b	7.7a
45.0	26a	1869a	42ab	0.15a	23.52a	0.82ab	7.4b
90.0	23ab	1814a	57ab	0.20a	29.78a	0.90a	7.0b

[1] *Means within the same column and year followed by the same letter are not significantly different at the 0.05 level by Tukey's multiple range test.*

decomposition rather than to the solubilization of pre-existing soil micronutrients as a result of decreased pH (Fresquez et al. 1991).

Changes in Blue Grama Forage Production and Quality

Normally, in the presence of a stimulus (e.g., fertilization), plant production increases while the diversity of plant species decreases (Biondini and Redente 1986; Houston 1979). Although the sludge amendments decreased total plant density, species richness, and species diversity (index of numbers of different species in relation to the total number of plants per given area), cover and yield of blue grama significantly increased on treated plots (Fresquez et al. 1990a). The positive effects of the sludge amendments on forage production are demonstrated by changes in blue grama production after the first, second, and fifth growing seasons (table 3). Blue grama production was significantly greater for all of the sludge amendments during the first and second growing seasons, with yields ranging from 1.5 to almost 3.0 times greater in the treated plots than in the unamended (control) plots. Summer precipitation during 1986 was exceptionally high and the highest yields of dry matter production occurred during this growing season. After the fifth growing season, blue grama production remained

Table 3. — Blue grama production (mean production and standard error, S.E.; n= 4) in control and sludge-amended plots after one, two, and five growing seasons, Rio Puerco Watershed Resource Area, NM.

Treatment (Mg ha^{-1})	Production (kg ha^{-1})	S.E.
	First Growing Season, 1985 (precipitation = 147 cm)	
0	270b[1]	22
22.5	480ab	96
45.0	433ab	100
90.0	509a	62
	Second Growing Season, 1986 (precipitation = 239 cm)	
0	392b	76
22.5	575ab	163
45.0	824ab	114
90.0	1067a	227
	Fifth Growing Season, 1989 (precipitation = 201 cm)	
0	281a	39
22.5	291a	75
45.0[2]	506a	51
90.0	500a	178

[1] *Means within the same column and year followed by the same letter are not significantly different at the 0.05 level by Tukey's multiple range test.*

[2] *Significantly different from the control at the 0.10 level by Dunnett's multiple comparison test.*

higher in the 45 and 90 Mg ha^{-1} sludge-amended plots, although the benefits of the added sludge had greatly diminished for the lowest (22.5 Mg ha^{-1}) sludge amendment.

Although average blue grama production for the 45 and 90 Mg ha^{-1} treatment plots remained nearly double that of the control during the fifth growing season, within treatment variation in blue grama production also increased, resulting in statistically non-significant differences ($\alpha = 0.05$) between the control and sludge-amended plots.

The sludge amendments also significantly increased the nutritional value of blue grama. Tissue N, P, K, and crude protein increased with the application of sludge to recommended tissue concentrations (Fresquez et al. 1991). Furthermore, most of the trace metals, including Cu and Cd, in blue grama plant tissue did not increase significantly during the five year study, thereby reducing concerns that these toxic elements could be transferred to grazing animals. This is a significant finding because concerns over heavy metal accumulations frequently limit sewage sludge application to land. Based on these cumulative results, Fresquez et al. (1991) concluded that a one-time sludge treatment ranging from 22.5 to 45 Mg ha^{-1} (10-20 tons $acre^{-1}$) would yield the best vegetation response without potential harm to the environment.

An unexpected benefit from the sludge treatment was a decrease in broom snakeweed, a toxic, non-palatable, competitive range plant (Fresquez et al. 1990a). The number of broom snakeweed plants in the sludge-amended plots decreased progressively over the four year period 1985-1988 following the addition of the various sludge treatments (table 4). The exact mechanism(s) responsible for the decline of broom snakeweed remains unclear, but the decline in snakeweed was concurrent with an increase in production. This observed decrease in broom snakeweed represents a significant finding in rangeland restoration research. Budd (1989) reported that broom snakeweed occupies over 16 million hectares in New Mexico, including over 62% of the state's grazing rangeland.

Table 4. — Mean density[1] of broom snakeweed *(Gutierrezia sarothrae)* in sludge-amended versus unamended plots (n = 4) on a degraded rangeland site, Rio Puerco Watershed Resource Area, north-central New Mexico. [adapted from Fresquez et al. 1990a]

Sampling	Sludge Amendment (Mg ha^{-1})			
Date	0	22.5	45	90
1985	3.9	2.0	1.8	1.0
1986	3.4	2.0	1.5	1.0
1987	3.5	1.5	1.2	1.0
1988	2.7	0.1	0.0	<0.05

[1] *Density values represent the number of plants per 0.5 m^2.*

Surface Hydrology Study

A second study was established in spring 1991 within the Sevilleta National Wildlife Refuge (fig. 1). The objectives of this study were: 1) to determine if and how changes in vegetation following sludge application influence runoff and surface water quality and, 2) to assess the fate of potential sludge-borne contaminants introduced to the environment through the application. The Sevilleta refuge, managed by the U.S. Department of Interior's Fish and Wildlife Service, provided an excellent opportunity to compare rangeland treatment effects because public access is restricted and livestock grazing is prohibited. Climate at the study area is arid to semiarid with mean annual precipitation ranging from 200 to 250 mm (Moore 1991). Within the study area, a blue grama/hairy grama (*Bouteloua gracilis/B. hirsuta*) dominated community was selected for study on a moderately sloping (6%) and strongly sloping component (10%-11%) of a stable alluvial fan. The deep, well drained soils were characterized as fine-loamy, mixed, mesic Ustollic Calciorthids formed in local alluvium and colluvium derived from limestone and sandstone.

Field and Laboratory Methods

Six pairs of runoff plots, each pair consisting of a treated (sludge-amended) and a control (no sludge) plot were established within two hillslope gradient classes (three treated and control plots per slope gradient class). Runoff plot dimensions (3 X 10 m) were identical to those used by USDA Agricultural Research Service investigators involved in the Water Erosion Prediction Project (WEPP) (U.S. Dept. of Agriculture ARS 1987). Therefore, results from this study might be applied to WEPP models for larger-scale predictions on runoff and sediment yield for semiarid grasslands. The experimental plots were bordered by metal flashing to prevent external water from entering the plots. The borders direct internal surface runoff to the base of the plots during rainfall events, where the water is collected in sample reservoirs (Aguilar and Loftin 1992). Sludge was applied to the plots in April 1991. The treatment was a one-time application of 45 Mg ha^{-1} municipal sewage sludge (dry-weight basis) provided by the Albuquerque Public Works Department.

Total precipitation during summer storms was measured with two standard rain gauges (rainfall collection buckets) and a self-activating recording rain gauge that records data for calculating storm intensity (mm hr^{-1}). The runoff plots were subjected to simulated rainfall in September 1991, after the vegetation had an entire growing season to respond to the sludge treatment, and then again in September 1992 following two growing seasons. The simulator distributed water simultaneously to a plot pair so infiltration and runoff yield could be observed and recorded on the control and

treated plots concurrently. Simulated rainfall input was equivalent to a high intensity summer thunderstorm common in the region (6-8 cm hr^{-1} for 30 minutes). Representative samples of the runoff water were obtained by manually stirring the contents in the collection reservoirs after each rainfall event, and were analyzed for nitrate-N and trace element content. Analytical tests followed standard procedures as outlined in Agronomy #9, Methods of Soil Analysis - Part II (Page 1982) and U.S. Department of Agriculture Handbook No. 60 (Richards 1969). Pre-treatment soil and vegetation characterization established uniformity between control plots and those subsequently treated with sludge. Analysis of variance techniques were used to test for significant differences between the treated and control plots in runoff yield and trace elements.

Results

Hydrologic Response to the Sludge Amendment

First-year natural storm runoff was significantly less from sludge-amended plots than from control plots (fig. 2). Runoff from control plots was 3.4 to 37 times greater than runoff from treated plots.

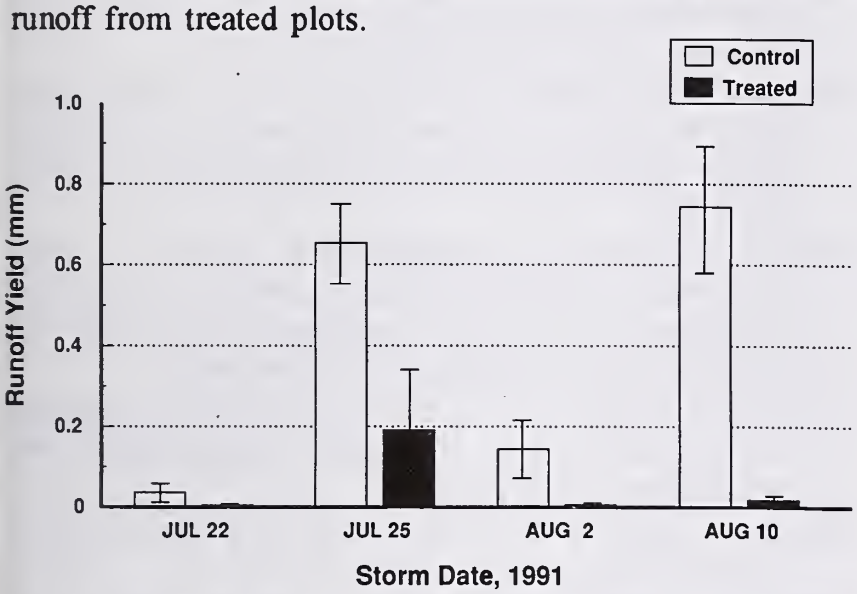

Figure 2. — Mean runoff yield from sludge-treated (n = 6) *versus* control plots (n = 6) during four natural storms, Sevilleta National Wildlife Refuge, 1991. Differences between control and treated plots were significant (α = 0.05) for all storms.

In September 1991, rainfall simulation experiments were conducted on the runoff plots (fig. 3). In stark contrast, runoff from control plots exceeded that from treated plots by 27 to >250 times. Runoff yields from our control plots are comparable to runoff yields measured during studies conducted in rangeland elsewhere in New Mexico and Arizona (Ward and Bolton 1991). Therefore, the hydrologic differences observed between our treated and control plots can be directly attributed to the sludge treatment.

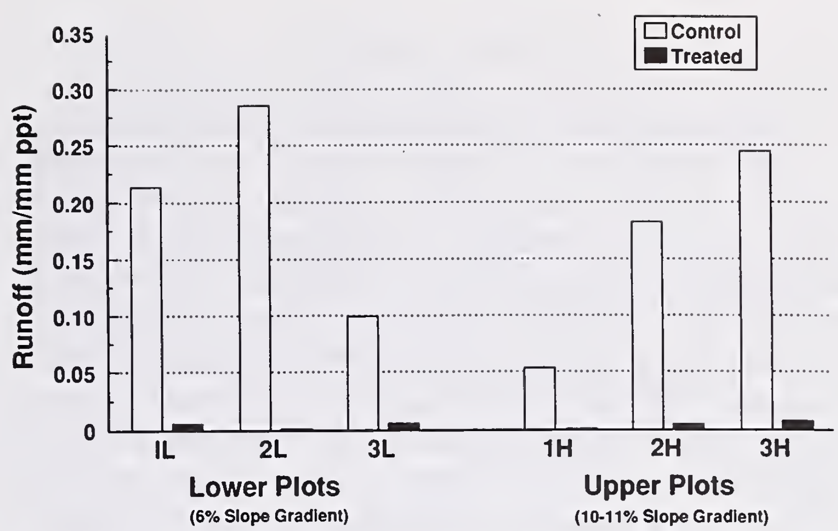

Figure 3. — Runoff from sludge-amended (treated) and unamended (control) plots during rainfall simulation experiments. Expression of runoff yield as runoff per mm of precipitation standardizes the runoff for comparison because precipitation input among and between plot pairs varied somewhat due to wind gusting.

The two factors we considered most important for the reduction in runoff on treated plots were increased ground surface roughness and water absorption by the dry sludge. Through time, the sludge should decompose and have a less direct effect on surface runoff, but increased plant productivity and ground cover could act to reduce runoff yields from the treated plots.

Second year data on runoff generated by rainfall simulation showed a similar pattern, with the surface-applied sewage sludge enhancing infiltration and reducing runoff. The importance of antecedent soil moisture effects on infiltration and runoff was demonstrated during our second series of rainfall simulation experiments (September 21 - 24, 1992). Total precipitation from natural storms between May 15 and September 21 1992 at the study site was only 97.5 mm compared to 182 mm during the same time interval the previous year (1991). Soil moisture conditions prior to the simulated rainfall inputs were therefore very low. Subsequently, runoff did not occur from any of the plots (control or treated) during the initial rainfall simulation runs (dry runs) because infiltration rates exceeded precipitation inputs under these dry soil moisture levels. Runoff was generated from the control plots only when the initial "dry runs" were followed with a second 40-50 mm rainfall application (wet run) 15 minutes later. However, wet runs on treated plots did not produce any runoff despite total rainfall inputs ranging from 70 to 109 mm.

Potential contamination of surface water by constituents in Albuquerque sludge does not appear to be a limitation for sludge application. Nitrate-N, Cu, and Cd concentrations in the runoff water were well below New Mexico ground water and livestock and wildlife watering limits, both during natural and simulated rainfall. No statistical differences (= 0.05) in these potentially toxic constituents were found between the treated and control plots (Aguilar and Loftin 1992).

CONCLUSIONS

Surface application of treated municipal sewage sludge can significantly increase vegetation cover and total forage production, and reduce runoff. Increased ground surface roughness and increased soil water-holding capacity reduce the rangeland's potential for runoff and water erosion. Subsequent increases in vegetation cover due to the sludge's fertilizer effect should further improve the surface hydrology of treated rangeland. Potential pollution of surface water by sludge-borne contaminants in city of Albuquerque sewage sludge, including heavy metals, does not appear to be a problem with a one-time application of 22.5 to 45 Mg ha^{-1} (10-20 tons/acre). Similar results could be expected using comparable sludges from other municipalities. Sludge application on semiarid rangeland has the potential for being environmentally and economically beneficial if these applications are based on sound guidelines developed through continuing research.

ACKNOWLEDGMENTS

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Diseases and Insects of Pine and Their Implications for Sustainability in Forests of the Southwestern United States and Northern Mexico

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Abstract — Most forest pathogens and insects are naturally occurring components of forest ecosystems. As such, they play critical roles in the dynamic forest processes of nutrient release, organic matter recycling, and succession of species. They also provide food and habitat for animals and affect short- and long-term structural diversity. However, epidemics of forest insects and pathogens may adversely affect sustainablility of forest ecosystems. This paper describes the major insects and disease-causing organisms and their potential effects on the sustainability of pine forests in the southwestern United States and northern Mexico.

DISEASES OF PINE IN NORTHERN MEXICO

As part of a continuing program of technical exchange between the USDA Forest Service and Mexico, the late Dr. Frank Hawksworth was privileged to make more than 15 trips to Mexico during the past three decades. He visited most of the pine forests from Baja California, Chihuahua, and Coahuila all the way to Chiapas, mainly in conjunction with studies on the taxonomy, hosts, and distribution of the "muerdagos enanos" (genus *Arceuthobium*). This section of our paper is derived from his records and observations, primarily in natural forest stands. Only those diseases with a strong potential to impact sustainability are discussed.

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Decays

Little information is available on decays of living conifers in Mexico. Dr. Hawksworth considered *Phellinus* (=*Fomes*) *pini* (Thore: Fr.) Pilat to be their most common trunk decay fungus. It fruits on several Diploxylon and Hapoxylon pines throughout Mexico. Numerous fungi decay *Pinus ponderosa* in the United States (Gilbertson 1974) and several of these undoubtedly occur in northern Mexico. The most serious decay fungus in living *P. ponderosa* in Arizona and New Mexico is the white rot fungus *Dichomitus squalens* (Karst.) Reid (= *Polyporus anceps* Pk.) (Andrews 1955). It also appears to be the major decay of *P. arizonica*, and probably other pines, in Chihuahua. Because this fungus enters the trunk through dead branches with intact bark, pruning branches from the lower trunk can minimize decay in future stands (Andrews 1955). In addition, *Fomitopsis* (= *Fomes*) *pinicola* and *Cryptoporus* (=*Polyporus*) *volvatus* (Pk.) Shear commonly fruit on dead pines.

Trunk decays in living trees primarily damage older trees. As such, decay fungi likely will be of much less importance in second-growth stands.

Root Diseases

In contrast to many North American forests, root diseases seem to be rather minor in Mexican conifers. Two common root disease fungi—*Armillaria* spp. and *Heterobasidion annosum* (Fr.) Bref. (= *Fomes annosus* (Fr.) Cke.)—occur in Mexico, but little is known of their abundance, host relationships, or importance. Armillaria root disease is sometimes seen in natural stands in Mexico, but it appears to be most common in plantations (for example, in *P. arizonica* and *P. radiata* plantations in Chihuahua). The species of *Armillaria* present in Mexico are not known although isolates from one area in central Chihuahua, where the fungus was killing young trees, were identified as *A. ostoyae* (Shaw 1989). Even less is known of *H. annosum* in Mexico, although Dr. Hawksworth observed it only near Uruapan, Michoacan, where it was causing high mortality in plantations of *P. patula* and *P. montezumae*.

Cone Rust

Cone rust, *Cronartium conigenum* Hedgc. & Hunt, is a serious disease of at least 15 species of pines and is widespread from southern Mexico to northern Chihuahua (Peterson and Salinas 1967). The rust, which completes its life cycle on *Quercus* spp., is damaging because affected cones produce no seeds. A rare rust of pine stems, described as *Peridermium mexicanum* Arth. & Kern, is considered to be an unusual infection site for *C. conigenum* (Peterson 1967).

Pitch Canker

More than 30 years ago George Hepting noticed what was apparently pitch canker in pine (*P. occidentalis*) forests of Haiti (Hepting 1953). Gibson (1978) noted a disease complex characterized by resin flow in a *P. patula* plantation in Mexico. However, the only fungus isolated was *Hyphodontia arguta*, a nonpathogen. Blanchette (1989) reported that pitch canker was an "extremely important disease" on *P. halapensis* in Chapingo, Mexico as well as in native pine forests in Jalisco. During travels in central Mexico, Dr. Hawksworth frequently noticed resinous cankers on pines but did not determine their cause. Most of these excursions were in native forests, not plantations. Mexican forest pest specialists (David Cibrian, Jorge Macias, Jose Cibrian, and Ignacio Carbajal) have recently noted pitch canker in several areas in central Mexico but we are unaware of their published reports. At the V Simposio Nacional sobre Parisitologia Forestal in Juarez, Mexico in October 1989, Dr. Hawksworth talked to several Mexican forest pathologists about pitch canker. The canker is now widespread in Mexico and is known from at least 8 states (Sinaloa, Nayarit, Mexico, Puebla, Michoacan, Jalisco, Durango, and, very recently, Tamaulipas). The latter locality is in northeastern Mexico only about 200 km. south of Brownsville, Texas. To date, pitch canker has been found on six species of pines (*P. ayacahuite*, *P. douglasiana*, *P. montezumae*, *P. michoacana*, *P. durangensis*, and *P. pseudostrobus*); all but the first are of the yellow pine group. Reports of new hosts or localities are increasing rapidly.

Early reports of the disease are difficult to verify, but pathologists think that it has been known in Mexico since at least 1985. There is still a lively debate as to whether pitch canker is native to Mexico or introduced. Considering that it has been detected in so many isolated areas, we suspect that it is a native disease that is showing up more frequently because more people are looking for it. Isolation and identification of organisms involved in these various sightings of pitch canker should markedly enhance our understanding of the disease in Mexico.

At the above-mentioned Simposio, Gutierrez-Rodriguez (1989) reported on pitch canker in Nayarit on the West Coast of Mexico. Here it was first detected in 1986 in stands of *P. douglasiana*. In 1988 the canker was found on 3,116 ha and 45% of the trees were infected. No data are given on tree ages or sizes but there was "occasional" tree mortality. The causal agent was determined as *Fusarium moniliforme* var. *subglutinans*, but confirmation of the identification is needed.

Dwarf Mistletoes

The "muerdagos enanos" are the most widespread and damaging conifer mistletoes in Mexico (Hawksworth 1980). Standley (1922) listed only one species (*A. vaginatum*) but we now know of 21 "muerdagos enanos" in Mexico, including 18 on *Pinus*, two on *Abies* and one on *Pseudotsuga* (Hawksworth and Wiens 1972, Rodriguez-Angeles 1983). More than 30 species of *Pinus* in Mexico are attacked. The USDA Handbook on dwarf mistletoes (Hawksworth and Wiens 1972) is currently being revised and should be published early in 1994 with updates on several species of dwarf mistletoe in Mexico.

Growth rates of mistletoe-infected trees are reduced relative to the intensity of infection. There is little or no effect of infection in the lower half of the crown, but growth rates are markedly reduced as infection increases in the upper crown. Gutierrez-Rodriguez (1970) studied the effects of *Arceuthobium* sp. on *P. hartwegii* and *P. montezumae* at Cerro Telepon, Mexico, and found that diameter growth of infected trees was 20-50% less than uninfected trees. Studies by Vera-Gaxiola (1985) on *P. hartwegii* infected by *A. vaginatum* and *A. globosum* at Zoquipan, Mexico, showed that infected trees were 31% smaller in diameter and 17% shorter than comparable uninfected trees. Andrade-Escabar and Cibrian-Tovar (1980) found that for the same host and

mistletoes the most recent annual growth in heavily infected (Classes 5 and 6, as per Hawksworth 1977) trees was only about half that in uninfected trees.

Although mortality rates of trees in heavily infected stands is increasing, no data are available to quantify this relationship in Mexico. Observations suggest that increased mortality is significant in many areas in Mexico:

- *Pinus teocote* and *P. leiophylla* var. *leiophylla* (*A. gillii* ssp. *nigrum*)—Durango
- *Pinus arizonica* and *P. engelmannii* (*A. verticilliflorum*) — Durango
- *Pinus leiophylla* var. *chihuahuana* (*A. strictum*) — Durango
- *Pinus leiophylla* var. *chihuahuana* and *P. lumholtzii* (*A. gillii* ssp. *gillii*)—Durango and Chihuahua
- *Pinus ayacahuite* var. *brachyptera* (*A. blumeri*) — Chihuahua and Durango
- *Pinus arizonica* and *P. engelmannii* (*A. vaginatum* ssp. *cryptopodum*) — Chihuahua
- *Pinus patula*, *P. teocote*, and *P. leiophylla* var. *leiophylla* (*A. gillii* ssp. *nigrum*) — Puebla
- *Pinus ayacahuite* var. *ayacahuite* (*A. guatemalense*) — Chiapas and Oaxaca
- *Pinus michoacana* and *P. pseudostrobus* (*A. vaginatum* ssp. *durangense*) — Jalisco
- *Pseudotsuga menziesii* (*A. douglasii*) — Chihuahua and Durango

Trees heavily infected with dwarf mistletoe are typically reduced in vigor and become more susceptible to attack by fungi and insects, particularly bark beetles. The relationship has not been quantified in Mexico but has been observed in a number of areas, for example, *Dendroctonus mexicanus* and *A. vaginatum* ssp. *durangense* on pines in the Sierra de Quila, Jalisco and on *P. patula* in Zacatlan, Tlaxcala (J. Beatty, personnal communication, 1993).

INSECTS OF PINE IN NORTHERN MEXICO

The dynamics of forest insects in temperate forests of northern Mexico differ from those in the southern and southwestern United States despite the close proximity. The diversity of forest conditions in the Sierra Madre Occidental in the states of Chihuahua and Durango has kept insect outbreaks to a minimum. Forest insects that are known to cause serious damage in the United States remain at endemic population levels within northern Mexican forests.

Various bark beetles occur in the forests of northern Mexico. For example, Perusquia-Ortiz (1982) noted *Dendroctonus brevicomis* Lec., *D. adjuntus* Blandf., *D. valens* Lec., *D. parallelocollis* Chap., *Ips lecontei* Swaine, and *I. plastographus* Lec. in Chihuahua and Durango. However, no outbreaks by these bark beetles have been noticed in northern Mexico for at least the last decade. The last significant outbreak of insects on adult trees was caused by the pine sawfly *Neodiprion fulviceps* Cresson, which severely defoliated *P. arizonica* Engelm. in San Juanito, Chihuahua in 1980 (Castro-Castañeda 1981).

Sporadic tree mortality caused by *Ips* species has been observed in natural regeneration and plantations (Sanchez-Martinez 1991). Attacks by *I. integer* Eichhoff, *I. pini* Say, and *I. bonanseai* Hopkins were reported on *P. arizonica* trees less than 10 years old in an area of natural regeneration produced by an experimental seed tree cut in Madera, Chihuahua (Sanchez-Martinez 1991). *Ips lecontei* Swaine killed a few hundred trees (*P. engelmannii* Carr.) in Guerrero, western Chihuahua (Sanchez-Martinez 1991).

The pine shoot borer, *Eucosma* sp., on *P. arizonica* and the pine tip moth, *Rhyacionia neomexicana* Dyar, on *P. engelmanni* and *P. arizonica*, occur in some areas in Chihuahua, but incidence and growth impact has yet to be assessed.

In contrast to these insects, *D. rhizophagus* Thomas and Bright, is a bark beetle that causes severe mortality on seedlings and saplings of several pine species (Thomas 1966, Thomas and Bright 1970, Sanchez-Martinez 1988, Estrada-Murrieta 1991). This species was confused with *D. valens* when first detected in Chihuahua and Durango (Thomas 1966), but was later identified as a new bark beetle species (Thomas and Bright 1970).

Since its discovery, *D. rhizophagus* has caused conspicuous mortality in pine regeneration (Thomas 1966, Thomas and Bright 1970). This beetle feeds on about 10 different pine species, including: *P. engelmannii*, *P. arizonica*, *P. durangensis*, and *P. leiophylla*. *Pinus engelmannii* seems, however, to be the most affected (Estrada-Murrieta 1991, Sanchez-Martinez 1991). Estrada-Murrieta (1991) points out that *P. ponderosa* from an experimental arboretum also was attacked by this insect.

Outbreaks of *D. rhizophagus* occur every year in the forests of Chihuahua (Estrada-Murrieta 1991, Sanchez-Martinez 1988). Over 2 million small pine trees were killed by this insect from 1977 to 1990 in the region "El Largo-Madera," northwestern Chihuahua, in an area of about 12,000 hectares (Estrada-Murrieta 1991).

Although S.L. Wood (1982) indicated that *D. rhizophagus* produces two generations per year, investigations in Chihuahua indicate only one (Sanchez-Martinez 1988, Estrada-Murrieta 1991). Larvae feed on the inner bark of stems in early fall, and the roots in late fall and early winter. They overwinter in roots as last instar larvae, pupate in roots from mid to late May, and then emerge as adults from mid June to early August. Detailed descriptions of the life cycle appear in Estrada-Murrieta (1991), and in Sanchez-Martinez (1988).

Estrada-Murrieta (1991) suggests that *D. rhizophagus* may be widespread along all the Sierra Madre Occidental in Mexico, but its status in forests of the southern and southwestern United States is unknown.

Forests in northern Mexico provide an excellent opportunity to study the influence of forest diversity (genetics and age of hosts, topography, and the abundance of resources) on insect population dynamics. Several pine species occur within short distances in any forested areas. Management practices have favored uneven-aged forests while maintaining good genetic diversity and preserving scarce old-growth forests. Classical treatments of forest health (e.g., Furniss and Carolin 1977, Zobel and Talbert 1984, Barbosa and Wagner 1989, Manion 1991) emphasize the importance of diversity in keeping forest pests at low population levels.

A major concern, however, is understanding what factors lead to outbreaks of *D. rhizophagus* in regeneration, and what threat this insect presents to natural regeneration in northern Mexico and the southern and soutwestern United States.

DISEASES OF PONDEROSA PINE IN THE SOUTHWEST

Ponderosa pine occurs over more acres (4 million, or 75% of the total acres with timber species) in the Southwest than any other type (Choate 1966). It also is the type most utilized for timber production. Ponderosa pine is a seral species that is gradually being replaced on some better growing sites by later successional species because of fire exclusion. This change has lead in part to an increase in insect and disease activity because it is restricted to less favorable growing sites. Many of the ponderosa pine forests in the Southwest are overstocked, stagnated, or have dense understories of young trees beneath the overstory (Wright 1990). Such conditions reduce individual tree vigor, increase susceptibility to bark beetles and root diseases, and promote spread and intensification of dwarf mistletoe.

The major diseases of ponderosa pine throughout its vast range in western North America are discussed by Hawksworth and Shaw (1988). Lightle (1967), Walters (1978a), and Hawksworth et al. (1989) describe diseases of ponderosa pine in the Southwest. This discussion draws heavily on Hawksworth et al. (1989) to emphasize diseases that are currently of concern to forest managers in the Southwest as they deal with issues of sustainability.

Even though diseases probably cause more damage to southwestern ponderosa pine than insects and fire combined, there are few quantitative data on losses. In addition to timber and recreation losses, diseases impact other resources such as wildlife habitat and scenic beauty (Baker and Rabin 1988). Data on these effects also are lacking, but the need for such information is increasing as foresters implement ecosystem management on a sustainable basis.

Dwarf Mistletoes

Southwestern dwarf mistletoe (*Arceuthobium vaginatum* (Wild.) Presl subsp. *cryptopodum* (Engelm.) Hawksw. & Wiens) is the most widespread and damaging disease agent of southwestern ponderosa pine (Hawksworth and Wiens 1972). The mistletoe occurs essentially throughout the range of ponderosa pine in Arizona and New Mexico, and also ranges north to Colorado and southern Utah; east to west Texas; and south to Sonora, Chihuahua, and Coahuila, Mexico. Southwestern dwarf mistletoe also is common on Arizona pine (*P. ponderosa* var. *arizonica* Engelm. = *P. arizonica* Engelm.) and Apache pine (*P. engelmannii* Carr.) in southern Arizona and New Mexico. In northern New Mexico, Rocky Mountain bristlecone pine (*P. aristata* Engelm.) is occasionally infected when growing near infected ponderosa pines. Nearly 40% of the ponderosa pine commercial forest area throughout the Southwest is affected by dwarf mistletoe (Maffei and Beatty 1988), but infection is much higher in some areas—up to 70% on the Lincoln National Forest in southern New Mexico, for example (Hessburg and Beatty 1986). Annual losses of wood volume in ponderosa pine due to dwarf mistletoe in the Southwest are estimated at 150-200 million board feet (Walters 1978b).

Dwarf Mistletoe Effects

Dwarf mistletoe affects ponderosa pine forests by reducing diameter, height, and volume growth; increasing mortality rates; decreasing seed production; reducing wood quality; and predisposing trees to attack by insects. Disease intensity in trees is commonly assessed using the 6-Class dwarf mistletoe rating (DMR)[1] system (Hawksworth 1977). In this system a tree with infection confined to the lower half of the crown would be Class 3. Growth is reduced markedly as the level of infection increases in the upper crown. For example, the last 5 years' radial growth of

1 For the DMR rating system, the live crown of a tree is visually divided into thirds and each third rated for mistletoe intensity as (0) for no visible mistletoe shoots or witches' brooms, (1) for light infection (less than half of the branches infected), or (2) for heaving infection (more than half of the branches infected). The ratings for each third are then added to obtain a tree rating, which ranges from "0" for a healthy tree to "6" for a tree heavily infected in each third. Ratings of all live trees (including uninfected trees) can be averaged to obtain a stand or plot rating.

ponderosa pine in New Mexico was reduced, respectively, 9%, 23%, and 53% for DMR Class 4, 5, and 6 (Hawksworth 1961). Infection by dwarf mistletoe, especially when severe, accelerates tree mortality. Most ponderosa pines that are killed by dwarf mistletoe have a DMR of 6. Mortality in ponderosa pine stands in southern New Mexico was about 3% over 10 years for trees with a DMR of 3 or less, and 9%, 12%, and 38% for Class 4, 5, and 6, respectively (Hawksworth and Lusher 1956). In a more detailed study followed for over 30 years at the Grand Canyon, mortality was related to mistletoe infection severity and tree size (Hawksworth and Geils 1990). Class 6 trees under 9 inches d.b.h. lived for an average of only 7 years, where as those over 9 inches lived for an average of 10 years. Comparable figures for trees in DMR Classes 4 or 5 were 17 years for small trees and 25 years for large trees. In addition, mistletoe-infected ponderosa pines at the Grand Canyon were more readily killed by fire than uninfected trees (Harrington and Hawksworth 1990).

Dwarf mistletoe infection can affect long-term sustainability of severely infected forests by reducing cone and seed production. Korstian and Long (1922) found that the "reproductive value" (yield of seed per pound X number of seeds per pound X germination percent) of severely infected ponderosa pines was about 75% less than that of comparable, uninfected trees. Ponderosa pines with a DMR of Class 4 or higher should not be left as seed trees (Myers 1974).

Ponderosa pines heavily infected with dwarf mistletoe are frequently attacked and killed by secondary bark beetles, primarily *Ips* spp. (Parker 1991; Stevens and Hawksworth 1970, 1984). There have been few studies on interrelationships between dwarf mistletoe and *Dendroctonus* beetles in the Southwest, but mortality caused by *D. adjunctus* in southern New Mexico is directly related to the severity of dwarf mistletoe infection (Parker et al. 1975, Stevens and Flake 1974). Wagner and Mathiasen (1985) studied a pandora moth (*Colorada pandora*) outbreak on the North Kaibab Plateau and found that, while all trees were defoliated, mortality was concentrated in pines that were severely infected by dwarf mistletoe.

Dwarf mistletoes influence ecological relationships in ponderosa pine forests (Linhart 1988), including the rate and direction of stand succession. For example, some ponderosa pine stands in the Southwest are being replaced by Douglas-fir (*Pseudotsuga menziesii*) because overstory pines are killed by dwarf mistletoe and immune Douglas-firs in the understory are released. Prior to European settlement, wildfires may have determined the distribution and intensity of dwarf mistletoes in coniferous forests. Fire exclusion policies during the past half century may have increased both infection levels and fire hazard (Alexander and Hawksworth 1974).

When dwarf mistletoe kills groups of ponderosa pines, understory vegetation and microclimate in the openings created are markedly affected. The increased "edges" created by such openings may enhance the wildlife habitat value to some birds and small mammals. Many species of birds and mammals forage on dwarf mistletoe shoots and seeds. Others utilize dense witches' brooms or dwarf mistletoe killed trees for nest sites. An association between higher levels of dwarf mistletoe infection and increasing bird populations and species diversity has been observed in Colorado ponderosa pine forests (Bennetts 1991, Bennetts and Hawksworth 1991). Stand conditions created by dwarf mistletoe infection (eg., lower crown canopy, witches' brooms, dead tops, dead trees, etc.) create a desired habitat. However, information is lacking on changes in bird species diversity and populations as stands become more severely infected and mortality increases.

Dwarf Mistletoe Control

Dwarf mistletoes can be effectively and economically controlled by cultural means (Beatty 1982, Hawksworth 1980, Johnson and Hawksworth 1985, Scharpf and Parmeter 1978), particularly even-aged cutting methods. Mistletoes are amenable to cultural treatments because:

1) They are obligate parasites; that is, they require a living host to survive. Once an infected tree or branch is cut it is no longer a threat.

2) They are generally host-specific and usually attack one host or a group of closely related species. Resistant species frequently can be favored to minimize losses.

3) They have long life cycles, i.e., the time from infection to seed production is 5-6 years, or longer. Long life cycles slow population build-up.

4) They have a slow rate of spread. Seed dispersal distances are usually less than 50 feet from the tops of overstory trees and 20-30 feet from smaller trees. Added to its long life cycle, this limits rate of spread of dwarf mistletoe through even-aged stands to about 1-2 feet per year.

5) They cause obvious damage. Damage due to dwarf mistletoe is readily apparent because of mistletoe plants, witches brooms, and declining or dead trees. Infested portions of stands can be readily delineated.

Various silvicultural treatments used to reduce damage caused by dwarf mistletoes are detailed in Hawksworth et al. (1989). Marsden et al. (1993) demonstrate the use of models to evaluate effects of southwestern dwarf mistletoe, alone or in combination with root disease.

Root Diseases

Root diseases affect ponderosa pine in many parts of the West where annual losses from these diseases are estimated at 240 million cubic feet per year (Smith 1984). Root diseases are a management concern on approximately 1.1 million acres in the Southwest (DeNitto 1985). Region-wide, they reduce growth and yield of timber by some 10% with estimates as high as 25% in seriously affected stands (Rogers and Hessburg 1985). A survey of commercial, timber-producing lands on six national forests in Arizona and New Mexico indicated that root diseases and associated pests were responsible for about 34% of the trees killed (Wood 1983). A larger proportion of the mortality was attributed to root diseases in mixed conifer and spruce-fir stands than in ponderosa pine.

Armillaria root disease, caused by one or more species of *Armillaria*, including *A. ostoyae* (Romagn.) Herink, (Shaw and Kile 1991), is fairly common throughout the ponderosa pine type in the Southwest, but damage is generally light (Wood 1983). A notable exception is in the Jemez Mountains of northern New Mexico, where Armillaria root disease causes extensive mortality in certain plantations (Weiss and Riffle 1971) and in one large natural forest that has been periodically logged by selective cutting for over 50 years (Marsden et al. 1993, R.E. Wood 1982). In this area, as commonly happens with root diseases, prior management activities seem to have exacerbated the root disease problem.

Annosus root disease caused by *Heterobasidion* (*Fomes*) *annosum* (Fr.) Bref. also occurs on ponderosa pine in the Southwest (Mielke and Davidson 1947), but damage is again slight (Wood 1983). Black stain root disease, caused by *Ophiostoma* (*Leptographium*) *wageneri* (Goheen & Cobb) Harrington, has been confirmed on Douglas-fir and pinyon (*Pinus edulis* Engelm.) in the Southwest (Harrington and Cobb 1986); however, *L. wageneri* has not been confirmed on ponderosa pine (T. Harrington personal communication, 1989). Although this disease was first described on ponderosa pine and pinyons (Wagener and Mielke 1961) and can be locally severe, it is of little consequence to management of either species in the Southwest.

Hawksworth et al. (1989) provide detailed descriptions for these diseases.

Decays

Trunk rots cause serious volume loss in southwestern ponderosa pine, particularly in old-growth stands (Andrews 1955). However, they also provide critical habitat for cavity-dependent wildlife and are instrumental in nutrient recycling and organic matter decomposition.

Red rot (also called red ray rot), caused by *Dichomitus squalens* (Karst.) Reid (= *Polyporus anceps* Pk.), is the major decay of living ponderosa pine in the Southwest (Andrews 1955, 1971). Andrews (1955) estimated that 15-25% of the gross volume in virgin stands in the Southwest is lost to red rot. The fungus commonly fruits on slash and sometimes on dead limbs of living ponderosa pine trees. Since bole infections emanate from infected dead branches over 1 inch in diameter with intact bark, branch pruning of the lower boles can reduce losses to red rot (Andrews 1955). Lightle and Andrews (1968) found that loss due to red rot in old-growth ponderosa pine on the Navajo Reservation in Arizona amounted to 15% of the gross volume. The light selection harvesting system then used removed 48% of the gross volume and reduced the volume loss to red rot to 9% in the residual stand.

Other decays of living ponderosa pine sometimes encountered in the Southwest are Red ring rot, caused by *Phellinus* (*Fomes*) *pini* (Thore.:Fr.) A. Ames; *Fomitopsis officinalis* (Vill.:Fr.) Bond. et Sing. (= *Fomes laricis* Jacq. ex Murr.), a brown cubical trunk rot; *Phaeolus* (*Polyporus*) *schweinitzii* (Fr.) Pat., a brown cubical butt rot usually associated with Douglas-fir; *Veluticeps berkeleyi* Cke., a dark brown cubical butt rot (Gilbertson et al. 1968); and *Lentinus lepideus* Fr., a brown cubical rot often associated with fire scars. Descriptions and keys to identification of these fungi and their decays appear in Gilbertson (1974).

Abiotic Diseases

An array of environmental factors affect ponderosa pine throughout the West. These include climatic extremes, winter drying, top kill due to cold, frost damage to foliage, drought, salt toxicity, herbicide damage, hail damage, and air pollution (Miller 1978).

Periodic droughts are the primary abiotic factor affecting ponderosa pine in the Southwest. Several consecutive years of below normal rainfall in the 1950's led to the death of thousands of ponderosa pines in Arizona and New Mexico, usually in association with secondary bark beetles (Lightle 1967). Ironically, most mortality occurred just after the drought was broken and rainfall returned to near-normal levels and patterns. Plant-parasitic and mycorrhizal-parasitic nematodes were studied in ponderosa pines in drought-affected and nondrought stands in New Mexico, but results were inconclusive (Riffle 1967, 1968).

Lightning is a primary mortality factor in old ponderosa pine trees in many areas in the Southwest (Pearson 1950).

Winter drying, also known as "Red Belt," is induced by drying winter winds when soil around tree roots is frozen (Schmid et al. 1991). It can cause spectacular damage to ponderosa pine and other southwestern conifers. Usually only foliage is reddened and killed, but tree mortality may occur in severe cases. Winter drying affected about 150,000 acres of ponderosa pine and Douglas-fir in northern New Mexico in 1985, but most trees recovered (Owen 1986). Hail damage also can be severe in the Southwest: for example, on the Mescalero Apache Reservation in the late 1950's a severe hailstorm almost completely stripped ponderosa pine foliage on over 6,000 acres, and many trees were killed.

Ponderosa pine is quite susceptible to excess soil salinity (Spotts et al. 1972). Along roadsides where salt is used for deicing, needles frequently become discolored and trees die (Scharpf and Srago 1974, Walters 1977). Ponderosa pine also is seriously affected by air pollution in some areas, particularly by ozone in southern California (Miller 1978). Studies in Colorado suggest that Rocky Mountain ponderosa pine is more resistant to ozone injury than coastal ponderosa pine (Aitken et al. 1984). Little pollution damage to ponderosa pine in the Southwest has been detected to date. Surveys to evaluate sulfur dioxide damage to native forest vegetation in Arizona and New Mexico were conducted for several years (Weiss 1974). Although unexplained needle flecking of ponderosa pine was found throughout the Southwest, this condition could not be attributed directly to sulfur dioxide emission sources, and no tree mortality resulted (Weiss 1974).

Pest Complexes

The concept that a single forest pest acting alone kills trees is gradually being replaced by a realization that tree death typically results from complex interactions among pathological, entomological, and environmental factors. For example, *Armillaria* spp. often act in association with other root diseases (Filip and Goheen 1982), and bark beetles can be attracted to ponderosa pines infected by root pathogens (Cobb et al. 1974, Lessard et al. 1985) or dwarf mistletoe (Stevens and Hawksworth 1970, 1984). The pest combinations reported by Wood (1983) and Livingston et al. (1983) emphasize the importance of these interactions as causes of tree mortality in the Southwest.

Much of the marking for selective harvest of old-growth ponderosa pine in the Southwest was designed to identify trees at risk to attack by bark beetles (Thompson 1940, Schubert 1974). Research is currently underway to determine if these high-risk trees are so categorized because of pre-existing root disease conditions (Omdal and Shaw, unpublished, 1993).

DISEASES OF OTHER PINE SPECIES

Southwestern White Pine

White pine blister rust, caused by the fungus *Cronartium ribicola* J.C. Fisch., is exotic to the Americas. It was discovered for the first time in the Southwest in March of 1990 on southwestern white pine near Cloudcroft, New Mexico (Hawksworth 1990). The extreme isolation of the outbreak suggests that it may have been a separate introduction rather than a result of spread from previously affected areas. Subsequent surveys indicate this disease is now present throughout most of the range of southwestern white pine in the Sacramento Mountains on the Lincoln National Forest and the adjacent Mescalero Apache Reservation (Hawksworth and Conklin 1990). Several areas on the Cloudcroft and Mayhill Ranger Districts are experiencing heavy levels of infection. Some seedling and sapling mortality has occurred, and branch mortality (flagging) is common on all size classes of southwestern white pine. Most branch flagging, topkill, and seedling mortality are associated with cankers that are 5-6 years old (Hawksworth and Conklin 1990).

Orange gooseberry (*Ribes pinetorum*) and southwestern black current (*R. mescalerium*) are the most common alternate hosts in the outbreak area. The rust is common on both species; however, *R. pinetorum* carries more inoculum, sustains more damage, and generally appears to be more susceptible to the rust (Hawksworth and Conklin 1990). Both species of *Ribes* are common along drainages and stand edges, and less frequent within stands.

This disease will likely have a major impact on the white pine population and mixed conifer species composition of the Sacramento Mountains during the next several decades. Rust damage will become increasingly more noticeable during the next several years. Young trees will suffer more damage and will be more easily killed by the fungus than older, larger ones. In 40 to 50 years there will probably be many large white pines surviving, but there will be a deficiency in the smaller size classes throughout much of the affected area. Most of the now-existing seedlings and saplings, and many of the poles, will likely have died. Regeneration will still occur, but most of it will succumb relatively quickly (Conklin 1992). There is a potential for this disease to spread, either by man's activities or by windblown spores, to other areas of southwestern white pine, limber pine, and bristlecone pine in the Southwest, and possibly to other susceptible species in northern Mexico.

Southwestern white pine is infected by two species of dwarf mistletoe in the Southwest (Hawksworth and Wiens 1972). Apache dwarf mistletoe (*A. apachecum* Hawksworth and Wiens) occurs from east-central Arizona and central New Mexico south to the Santa Catalina, Rincon, and Chiricahua Mountains of Arizona. *Arceuthobium blumeri* A.

Nelson ranges southward from the Huachuca and Santa Rita ranges in southern Arizona through the Sierra Madre Occidental to southern Durango in Mexico. Witches' brooms on southwestern white pine are consistently produced by *A. apachecum* but only rarely by *A. blumeri*.

Chihuahua Pine

Chihuahua pine (*Pinus leiophylla* var. *chihuahuana*) is infected by chihuahua pine dwarf mistletoe (*A. gillii* Hawksworth and Wiens subsp. *gillii*) in southeastern Arizona, eastern Sonora, western Chihuahua, and Sinaloa (Hawksworth and Wiens 1972). In 1989, extensive mortality (over 1,700 acres) of chihuahua pine occurred in many drainages in the Chiricahua Mountains of southeastern Arizona (Wilson and Fairweather 1990). This mortality was attributed to severe infection by chihuahua pine dwarf mistletoe coupled with drought.

Pinyon Pine

Nine of the 15 species of pinyons are parasitized by dwarf mistletoes. Three dwarf mistletoes are known to parasitize pinyons, but only two (*A. divaricatum* and *A. pendens*) are restricted to them.

Arceuthobium divaricatum Engelm., by far the most widely distributed pinyon parasite, occurs essentially throughout the ranges of the two most common pinyons in the United States: *Pinus edulis* and *P. monophylla*. The dwarf mistletoe also parasitizes *P. californiarum* subsp. *californiarum* in California and subsp. *fallax* in Arizona, but usually in areas where these trees occur near infected *P. edulis* or *P. monophylla*. The mistletoe also occurs on *P. discolor*, but only at the northern limits of the tree in southern New Mexico where it comes in contact with infected *P. edulis*. *Pinus quadrifolia* is commonly attacked by *A. divaricatum* in the Sierra Juarez (and possibly also in the Sierra San Pedro Martir) in Baja California, Mexico (Hawksworth et al. 1968). This is the only known distribution of *A. divaricatum* in Mexico; it has not been discovered in the vast pinyon forests of central or northern Mexico. The only known occurrence of *A. divaricatum* on *P. cembroides* subsp. *cembroides* is at the northern limits of the tree in the Davis Mountains of western Texas. *Pinus cembroides* subsp. *cembroides* is the only pinyon in these mountains although *P. edulis* is parasitized by the mistletoe at the trees' southern limits in the Sierra Diablo, about 100 km NW of the Davis Mountains.

The Mexican *A. pendens* Hawksw. & Wiens is the only other dwarf mistletoe restricted to pinyons. The distribution of this, apparently rare, species is poorly known as it has been collected in only two localities: on *P. discolor* in the Sierra San Miguelito in San Luis Potosi and on *P. cembroides* subsp. *orizabensis* at Frijol Colorado, Veracruz (Hawksworth and Wiens 1980). The mistletoe is very common at the Veracruz site, but a limited population in the Sierra San Miguelito was found only on *P. discolor*, and not on closely associated *P. cembroides* subsp. *cembroides*. *Pinus discolor* is the only pinyon known to be parasitized by two species of dwarf mistletoes.

Pinus culminicola is rarely parasitized by *A. vaginatum* (Wild.) Presl subsp. *vaginatum* in Cerro Potosi, Nuevo Leon. The mistletoe is common in *P. rudis* stands and the understory *P. culminicola* may also be attacked (Hawksworth and Wiens 1972). However, this type of pinyon parasitism is different in that the mistletoe is not primarily a parasite of pinyons.

Like ponderosa pine, pinyons also are attacked by various needle casts and needle and stem rusts, but these occurrences are usually of minor importance and thus have little effect on long-term sustainability.

INSECTS OF PINE IN THE SOUTHWEST

Although numerous insects attack pine trees, bark beetles can most markedly affect the sustainability of pine forests in the southwestern United States and northern Mexico. Direct effects of bark beetle attack are tree mortality, top-killing, and changes in stand structure and composition. Bark beetle outbreaks also can affect successional changes in mixed and pure stands of ponderosa and pinyon pines, advancing succession in some cases, and setting it back in others. Effects on forest resources include: decreased timber production and value, increased water yields, increased forage production, increased food and habitat for some wildlife species while decreasing the same for others, and increased fire hazard.

Bark beetle populations generally are low in southwestern pine forests, and associated mortality is the result of normal or endemic infestations that are continuously present in mature forests (Furniss and Carolin 1977). Bark beetle outbreaks do, however, periodically occur where tree densities are high and there is a preponderance of low-vigor, highly stressed host trees. Besides high tree densities, bark beetle outbreaks are usually associated with other stress factors such as root disease, needle casts, and dwarf mistletoe; they often are triggered by drought or tree injury caused by logging, fire, or windthrow. Where these outbreaks occur, they often kill vast numbers of trees over large areas and can set the stage for devastating fires.

Two genera of bark beetles, *Dendroctonus* and *Ips*, have the potential to markedly affect pine sustainability. The significant species of pine bark beetles in the Southwest are roundheaded pine beetle (*D. adjunctus*), western pine beetle (*D. brevicomis*), mountain pine beetle (*D. ponderosae*), Arizona five-spined engraver (*I. lecontei*), and pinyon engraver (*I. confusus*).

The roundheaded pine beetle is one of the most serious bark beetles in the southwestern United States. It occurs in Colorado, Utah, Nevada, Arizona, New Mexico, Mexico, and south to Guatemala (Chansler 1967, Furniss and Carolin 1977). Its principal host in the United States is ponderosa pine. From Mexico southward, it infests several pines including Mexican white pine (*Pinus ayacahuite*), Chihuahua pine (*P. chihuahuana*), Montezuma pine (*P. montezumae*), and Nicaragua pine (*P. pseudostrobis*) (Massey et. al. 1977).

Periodic outbreaks of *D. adjunctus* have killed large numbers of pole- and sawtimber-sized ponderosa pine, particularly in New Mexico. In 1950, 16,000 pole-sawtimber-sized trees were infested on 2,500 acres near Cloudcroft, New Mexico (Lucht et. al. 1974). A smaller outbreak affected several hundred trees near Ruidoso, New Mexico, in the early 1960's (Chansler 1967). In the early 1970's, an estimated 400,000 pole-sized ponderosa pines were infested on over 150,000 acres from Mayhill to Ruidoso, New Mexico (Flake et. al. 1972). Between 1990 and 1992, an outbreak of roundheaded pine beetle, in association with western pine beetle, larger Mexican pine beetle (*D. approximatus* Dietz.), and several species of Ips beetles, killed an estimated 100,000 ponderosa pines over some 87,000 acres in the Sacramento Mountains of New Mexico (Bennett 1992). Smaller, yet significant outbreaks also have occurred in the Pinaleno Mountains of southern Arizona (Wilson 1993).

Outbreaks seem to develop on poorer sites and on ridgetops (Massey et al. 1977). The beetles can attack and kill trees in all crown and diameter classes and in groups from 3 to over 100. The beetle may kill up to 50% of the trees in pure stands of ponderosa pine, including both small- and large-diameter trees (Massey et. al. 1977). However, sustainability of pine may be most affected in mixed conifer stands where the beetle may kill a high proportion of pine, thereby leaving Douglas-fir or white fir (Abies concolor) as the dominant species. In such cases, the sites may convert to predominantly Douglas-fir and white fir, eventually eliminating the presence of ponderosa pine.

Unacceptable mortality can be prevented or minimized in most cases by maintaining trees or stands in good growing condition. Thinning and control of dwarf mistletoe in dense young stands likely will minimize potential killing by this beetle (Furniss and Carolin 1977).

Western pine beetle is periodically destructive to ponderosa and Coulter pine (*P. coulteri*). It is most damaging in California, but its range extends northward into Oregon, Washington, Idaho, and southern British Columbia; eastward into Montana, Nevada, Utah, Colorado, Arizona, New Mexico, and western Texas; and southward into northwestern Mexico (DeMars and Roettgering 1982).

This beetle normally breeds in overmature or root-rotted trees and windfalls, or in trees weakened by drought, stand stagnation, lightning, or fires (Furniss and Carolin 1977). Under these endemic, low-level populations, ponderosa pine mortality is widely scattered and insignificant. Infrequent outbreaks of this beetle do occur in the Southwest, usually in association with drought, and can cause significant mortality—particularly in densely stocked stands. During 1980-1982, a western pine beetle outbreak south of Flagstaff, Arizona, killed thousands of ponderosa pines over hundreds of acres (Telfer 1982).

Severe outbreaks of western pine beetle can adversely affect sustainability of pine if mortality rates are extremely high or if an outbreak is followed by catastrophic fire. However, mortality caused by this beetle usually will not have a major impact on pine sustainability. In general, such mortality may be considered part of the normal successional process through which a forest matures and replaces itself (DeMars and Roettgering 1982).

Many techniques and treatments have been attempted to suppress outbreaks of this beetle. Most have failed to reduce tree mortality significantly. However, mortality can be minimized by maintaining thrifty, vigorous trees or stands. Reducing stand stocking to 55-70% of that needed for full site utilization should relieve competitive stress among remaining trees, improve their vigor, and make them less prone to successful attack (DeMars and Roettgering 1982).

Mountain pine beetle is the most destructive bark beetle of pines in the western United States. Its range includes British Columbia, Alberta, the western United States, and northern Mexico (Furniss and Carolin 1977). Sugar pine, (*P. lambertiana*), ponderosa, lodgepole (*P. contorta*), and various white pines are major hosts; several other pines are occasionally infested.

Significant losses in the Southwest have been limited to the Kaibab Plateau of northern Arizona where an estimated 12% of the ponderosa pine type—totaling 300 million board feet of timber—was killed by this beetle during 1916 to 1926 (Furniss and Carolin 1977). Since then, three localized and low-level outbreaks have occurred on the Kaibab Plateau (Parker 1980).

As with other bark beetles, severe outbreaks that result in high levels of localized mortality may adversely affect pine sustainability, particularly if they are followed by catastrophic fire. In most instances, however, pine will regenerate and continue to occupy attacked sites following even the most severe outbreaks. Maintaining second-growth stands at or below 120 square feet of basal area will reduce susceptibility (Schmid and Mata 1992) and may thus enhance sustainability.

The Arizona five-spined engraver beetle is the most destructive pine bark beetle in central and southern Arizona (Furniss and Carolin 1977). It ranges from northern Arizona and southwestern New Mexico south into Honduras (Massey 1971, Parker 1991). Ponderosa pine is the principal host in the southwestern United States. The beetle attacks fresh slash and weakened trees; and, as multiple generations quickly build up, live trees may be attacked and killed.

Thousands of pole-sized trees can be killed during severe outbreaks, depleting 80-99% of all trees 3 inches in diameter at breast height and larger in heavily attacked stands (Parker 1991). While such losses may be significant in the short-term, long-term sustainability of pine at these sites may not be adversely impacted. Moreover, beetle-caused losses can be effectively prevented through proper utilization of harvested trees, proper timing of management programs, avoidance of programs that create slash for more than 1 year, and proper disposal of slash (Parker 1991).

The pinyon Ips beetle occurs in California, Nevada, Utah, Colorado, New Mexico, Arizona, and Mexico. It attacks Colorado pinyon (*P. edulis*) and singleleaf pinyon (*P. monophylla*), and occasionally other pines (Furniss and Carolin 1977). Outbreaks are common in the Southwest and quickly develop in trees that are injured or uprooted as in clearing land for range improvement. Outbreaks also may be initiated by drought (Wilson and Tkacz 1992).

Mortality rates can be high, as experienced during an outbreak on the Apache-Sitgreaves National Forest, Arizona, from 1990 to 1991, in which thousands of pinyon pines were killed over some 24,000 acres (Wilson and Tkacz 1992). This outbreak not only reduced the number and basal area of pinyon pines, it also affected the stand composition. In some stands, pinyon dropped from 62% to 53%, while juniper increased from 38% to 47%. In most cases, however, these beetles function primarily as thinning agents and do not adversely affect long-term sustainability of pinyon pine. Furthermore, sustainability of pinyon on these sites may be enhanced by maintaining pinyon and pinyon/juniper stand basal areas under 100 square feet.

CONCLUSIONS

The health and subsequent sustainability of our forests are items of long-standing interest to entomologists and pathologists. To address current "ecosystem management" issues, pathologists and entomologists are taking an ecological perspective as the spatial and temporal scales of their analyses increase from trees to stands to landscapes, and from tomorrow's to next year's to the following century's conditions. The crucial, overall point is that understanding processes related to forest health and thus sustainability will necessarily require attention to organisms that pathologists and entomologists have long studied. The ecology of these organisms is linked to the roles of fire, climate change, effects of past timber harvest activities, and other highly interactive processes driving forest succession (Monnig and Byler 1992).

Plant pathogens and insects are responsible for many dynamic changes in forest ecosystems. With a few notable exceptions, however (e.g., Dinoor and Eshed 1984, Franklin et al. 1987, Worrall and Harrington 1988, Burdon 1991, Kile et al. 1991), roles of pathogens and insects in forest dynamics have not received adequate attention. Pathologists and entomologists were the pest specialists, and stands requiring their attention were traditionally "unhealthy." Fortunately, this view is changing and pest specialists are more frequently interacting synergistically with forest managers in the decision-making process from planning to implementation of on-the-ground activities (Eav et al. 1989, Tkacz 1989).

The absence of pest outbreaks has been a traditional criterion for health at the stand level. However, insects and pathogens are prominent ecological and evolutional forces in forests. Disease outbreaks in individual trees or as stand level gap-making phenomena may be regarded as part of normal forest succession. The line between endemic and outbreak levels of pest activity is arguable on a case-by-case basis, and the scale and intensity of outbreaks that prompts a direct management response may depend less on professional measure than on stand or landscape management objectives. Further, a forest may appear healthy but be vulnerable to stress and pest outbreak. A high risk at a large scale may elicit a management response in stands that are otherwise apparently healthy.

Loss of productivity relative to the productive potential of a site is often proposed as a symptom of poor forest health and thus a deterrent to continued sustainability. We use productivity here as an ecological process, but note that forest productivity can also be a management objective. The questions of productivity, as well as for sustainabality, are: for what, for whom, and for how long? These questions are not answered by science. As a process, forest productivity has been affected by land settlement, patterns of land use, climatic preconditioning, introduction of exotic organisms, and changes in population genetics.

The involvement of insects and pathogens in forest diversity is complex. At the genetic level of diversity there is clearly a coevolutinary play between pests and hosts (Burdon 1991). Tree geneticists orchestrate this play by developing pest-resistant tree strains. However, the play is by no means limited to trees (Furman and Trappe 1971), and the game takes a long time relative to the manager's planning horizon. At the species, community, and landscape levels, the response of forests to insects and pathogens may affect biodiversity variously depending upon the measure of diversity and upon the sensitivity of that measure to the evenness and richness component (Musselman et al. 1992).

A healthy, sustainable forest is sometimes considered, especially by managers and their publics, to be a forest which can meet future goals (Monnig and Byler 1992). This is clearly a social, rather than an ecological, opinion. However, the "desired future condition" raises the question of succession and predictability. The introduction and spread of exotic diseases, such as white pine blister rust, are serious limitations to mid- or long-term predictability. Forests also

can be at risk when climate-induced stresses occur. For example, oak decline in eastern North America may have a long, causative history of climatic stress.

Reading the future is only partly a question of present forest composition and the application of successional models. Elements of surprise (e.g., Kay 1991) lie heavily in the domains of plant pathology and forest entomology. The sciences of forest pathology and entomology have broadened well beyond direct effects of insects and diseases upon timber production. These "pests" are integral components of forest systems and need to be examined and understood in ecological contexts.

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Global Change, Earth System Science, and Sustainable Development

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Abstract — The concept that the global environment can be studied as a coherent entity is presented in light of recent developments in our ability to measure and model systems. This scientific paradigm is providing new visions for the management of natural resources. A key concern is how to use detailed local knowledge in regional and eventually global scale analysis. This is needed in order to understand and predict the vulnerability of regional systems. This understanding requires broadly interdisciplinary research that cuts across many spatial scales and incorporates the needs and special interests of many different "actors" in the regional natural resources community. We are addressing this need by applying a "structured system analysis approach" that allows scientists to interact with other regional stakeholders for the purpose of jointly agreeing on the conceptual components of the analysis. Specific models and data sets to apply the models will result from global change research programs supporting the IGBP (HDGC and GCTE), IPCC, SBI and similiar efforts. To demonstrate the feasibility of this new concept of regional analysis, TERRA is conducting pilot tests. The pilot tests are addressing a water availability/allocation issue in a multi-county region and a broadly conceived regional sustainability issue in the Rio Grande/Rio Bravo basin. Current progress in the pilot tests is described.

INTRODUCTION

Global change is a concept that involves not only global climate change but population growth, increased industrialization, increased pollution, increased demand for and use of agricultural, water, range, and forest resources. These increased demands are accompanied by increased awareness of the environment and growing concern that it be managed in a sustainable manner.

As an issue, global change suggests that humans are influencing the environment, the entire earth system, on a global scale. We have long known that people affect resources locally but in the 20th Century we have learned that the local effects expand to regional effects and to global effects as population and industrial production increase. Acid rain in Europe and the United States illustrates regional impacts while measurements of CO2 in the atmosphere illustrate the global scale of impact. The United Nations Conference on Environment and Development (UNCED) last summer highlighted recognition of the global nature of environmental concerns and showed a global commitment to seek unified solutions to these problems. But how does this global awareness and political action relate to the operational sustainability issues addressed in this forum?

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Earth System Science is a modern perspective developing out of the global geophysics community that suggests the earth can only be understood as an interacting whole. Atmosphere, oceans and terrestrial systems are influenced and influence each other as well as the human experience influences and is influenced by them. All of the geophysical domains are interconnected and must be included, along with human dimensions, in any study of "earth futures". The earth is a unified system with atmosphere, oceans, land and humans all interacting with each other, exchanging energy, water and other chemicals between each other. One of the postulates of earth system science is that it is possible to understand and mathematically describe, simulate or model, many of the processes of behavior within and between each of these components, especially the atmosphere and the oceans. In turn by combining these models future system behavior and its response to perturbations can be predicted. For example, scientists have constructed global atmospheric general circulation models that predict tomorrow's weather based on today's observed conditions. These models are not prefect, in part because the system exhibits so called chaotic behavior but they are good enough to suggest possible climate futures.

Recognizing that the system is complex and can behave in a broad array of alternative ways does not diminish the significance of the ability to predict. Indeed, it suggests it might be wise to attempt to understand fundamental processes and use modeling techniques to predict possible futures for the entire system. How does this consideration of a complex process oriented formalism designed to allow prediction of future system states relate to the questions of operationalizing sustainability addressed at this Symposium?

Sustainability is a concept that has become increasingly popular in the past few years. The Bruntland Commission on Environment and Development, the originator of the UNCED Conference in Brazil, defined sustainability as the maintenance of options for our children. This rather captivating definition provides a useful starting point for discussion. Not simply content to survive, we humans develop philosophies, follow religions, and support governments that teach us to be responsible stewards of our earth system. This Conference is devoted to sustainable systems in yet each of us probably has a somewhat distinct view of, first, what sustainability is and second, how we might achieve it. Clearly, the consideration of "intergenerational equity" introduces long time frames into our considerations. In particular, is there a role for the type of large scale scientific activities mentioned above in the operationalization of sustainability being addressed here?

This paper will seek to provide some discussion of the three questions raised above:

How does this global awareness and political action relate to the operational sustainability issues addressed in this forum?

How does this consideration of a complex process oriented formalism designed to allow prediction of future system states relate to the questions of operationalizing sustainability addressed at this Symposium?

Is there a role for the type of large scale scientific activities mentioned above in the operationalization of sustainability being addressed here?

In the next section, we touch briefly on the state of science in global scale prediction in the geophysical sciences. We highlight the interconnection with terrestrial ecosystems and with human influences within these systems. The third section introduces the thought that Regional Analysis is a necessary stepping stone toward realistic global scale forecasting. The fourth section provides an overview of the structured systems analysis approach being developed at TERRA and provides background on the current pilot tests being developed to test its viability. The fifth section briefly outlines the scope of the modeling complex TERRA is developing and relates the process understanding research being conducted in various programs of the US Global Change Research Program to it. This section outlines a scientific plan to incorporate this broad and interdisciplinary modeling into regional analysis. The final section summarizes the discussions and suggests a planned path for TERRA.

THE STATE OF GLOBAL SCALE SCIENCE

Climate Prediction

It is possible to predict the behavior of the coupled atmosphere ocean system. Scientists have developed comprehensive general circulation models based on solution of the equations that represent conservation of mass, momentum and energy for the system. The equations are nonlinear and do not admit closed form solutions. They must be solved numerically over a global grid. The resolution of this grid is related to the ability of the models to address spacial scales and is on the order of 5° by 5° latitude and longitude. The equations that are solved are nonlinear parabolic differential equations that involve a discretization of time, as well as the space discretization mentioned above. Generally the time step involved in solution is on the order of minutes so that fine scale temporal detail is inherent in the model. The spacial scale is quite another matter. Generally the spacial scale of model prediction is on the order of 10 degrees of latitude and longitude, a very large scale indeed for any human interests. Although these models contain sufficient physical understanding to predict, for example, that the global temperature will increase with increases in the CO_2 (and other "greenhouse gas") concentration in the atmosphere. they are unable to predict

the precise manner in which this fact will manifest itself in regional climates of interest to the human community. Regional prediction is beyond the current state of the science because of the resolution problem as well as associated problems of the physical representation of cloud, hydrologic cycle and other phenomena. Figure 1 indicates the nature of phenomena that need to be included in climate system prediction. Considerable research is going into regional prediction, cloud representation and a host of associated problems.

An added issue of concern to those who would use the results of these models for policy and other decision making, is the inherent chaotic nature of the climate system. The equations describing the system are chaotic, that is they exhibit a property known as "sensitive dependence on initial conditions". For this reason the predictability of circulation models and hence of future climate is limited. Again, this limitation is most significant from a users point of view in that it suggests all results be couched in probalistic frameworks. Precise details of future system states can not be predicted. This is problematic because, as humans, we experience the precise details of the climate system as the weather that affects us. Thus, while the good news is that there is considerable power in the ability to predict future states of the climate, the bad news is that it is not, and will not in the near future (10 years) be possible to predict whether the Colorado River Basin, or the Rio Bravo Basin. will be warmer, wetter, colder or dryer over the next 50 years. We can predict, however, with reasonable certainty, that climate will be different than it has been in the past. Even this prediction, however, is not without controversy.

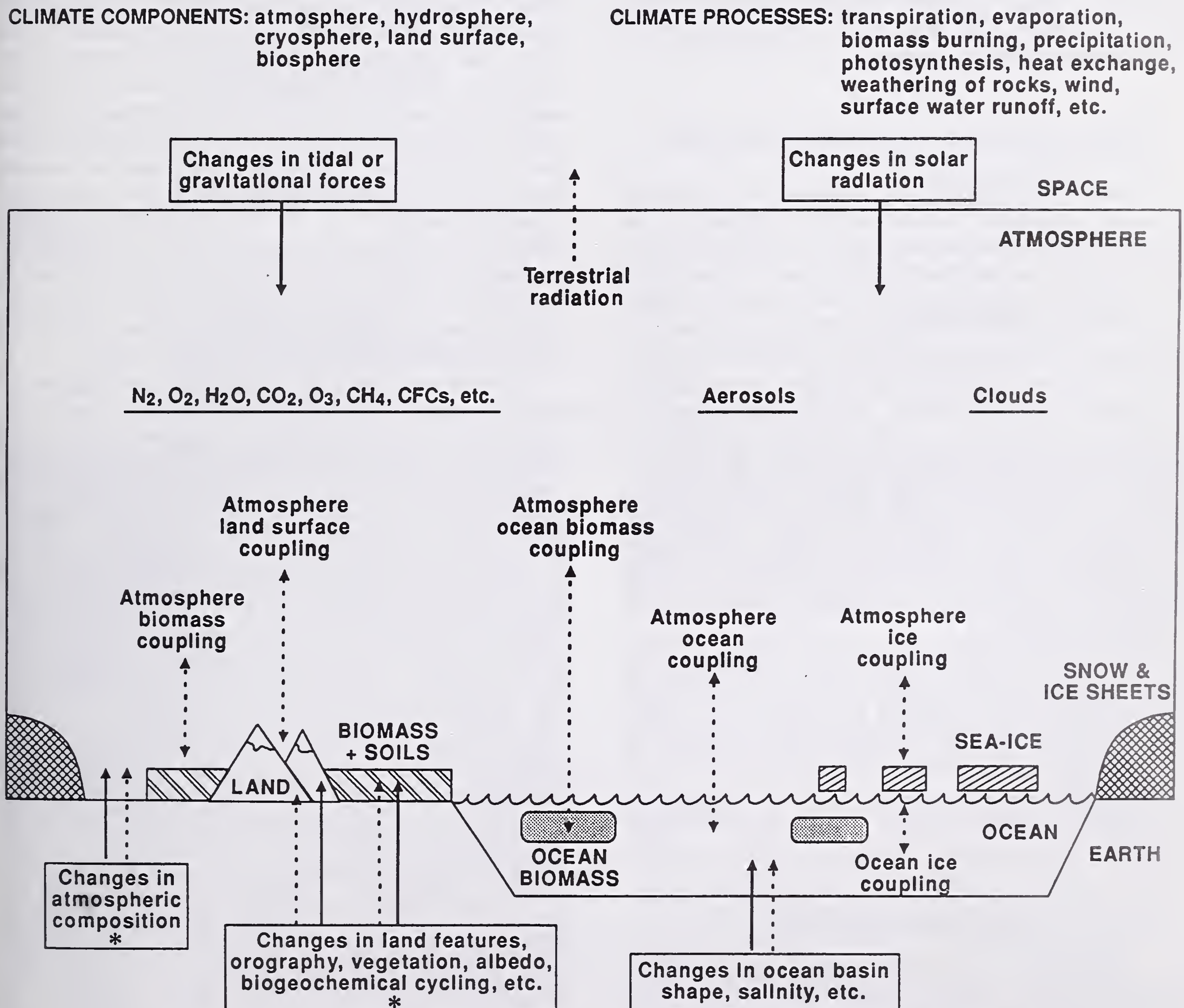

Figure 1. — A schematic representation of processes involved in the prediction of climate change.

Global Observations

Although, models have been important in defining the global change issue, the observation capability of the developing stream of satellite born sensors is of even greater value. These sensors are able to observe the entire earth system with spacial resolution below a few meters and temporal resolution from hourly to daily. Coupled with aircraft and surface platforms the measurement capabilities are truly remarkable. Although there is considerable research still needed remotely sensed data have transformed the capability to collect information about the earth system. The primary point here is simply that these data are available and will continue to improve our ability to look at the current condition of the earth system. Data for prescription of initial and boundary conditions needed to populate large scale ecosystem models, previously a significant limitation on the ability to validate and apply such technologies, will no longer be the barrier it has been.

Global Ecosystem and Human Interactions

Global Change research has considered the inclusion of terrestrial ecosystems because of their relevance to the climate processes illustrated in Figure 1. Considerable effort has been addressed to the problem of how to characterize the atmospheric feedbacks from the terrestrial system. Vegetative cover alters the albedo, affecting the receipt of solar energy as well as it's reflection. It also alters the energy balance both directly through heat storage in the canopy and, more significantly, indirectly through latent heat flux affected by transpiration, soil moisture and other soil properties. As well as the climate changes the vegetation cover is likely to change. This dynamic feedback does not exist in any models at the present time but it is a focus of some attention in the IGBP/GCTE program. This program is already developing mechanisms of modeling the global vegetation distribution given a particular expression of the climate from a GCM.

Hydrologic cycle interests, as expressed in the IGBP/BAHC are concerned with improving the representation of the physical processes of the energy balance and the water vapor flux in GCMs. Both of these programs will be described in more detail in the Section on model design.

Human dimensions of global change are summarized in Figure 2.

REGIONAL ANALYSIS

A "Region" can be defined in many different ways, each having their own special significance. For example, regions can be defined climatically as areas having a similar range of precipitation, temperature, evapotranspiration, seasonality or whatever other weather variables one chooses; hydrologically as watersheds, river systems or drainage basins; topographically as mountain ranges, valley systems, or other relief features; geologically as areas with similar geologic history, composition, etc.; ecologically as areas with similar vegetative potential; and so forth. Regions can also be defined politically, demographically, economically, ethnically and so forth. Thus, any specific geographic location can be considered part of a number of different regions depending on how they might be defined. Thus, the definition of what constitutes a region and why is not a trivial issue.

Regional analysis is conducted for various purposes and is receiving significant attention within the global change and ecosystem sustainability research communities. From the global change viewpoint, regions represent building blocks in reaching a global understanding. A major question is can regions that represent physical/climatological homogeneity, eg tropical rainforests, semiarid lands, desserts, etc. be modeled in a single manner? Considerable attention is being addressed to conduct of studies in selected examples of these general types. Is a particularly fertile area of research because, until very recently, the observational tools and theoretical models have not been available to address regional scales. Those interested in ecosystem sustainability are studying regions from a somewhat different perspective. In addition to physical, chemical and biological questions, critical issues are social, economic and political in terms of markets, living standards and other human values.

There are two areas of science that are important in regional analysis. One relates to scale, how much fine grained detail is needed to properly characterize the regional significance of the issue in question. The second is a more conceptual one that relates to the breadth of the analysis and the relevance of hierarchy to the analysis. This might be termed "Whose paradigm is the right paradigm?".

Scale questions exist in somewhat different form in all of the different intellectual communities studying regions. Physicists attempting to predict regional climate need stomatal control of transpiration to properly represent water flux, hence detail of individual tree and canopy architecture may be important. Ecologists are concerned with nitrogen availability and its control on productivity so that fine root chemical processes may be critical. Hydrologists need information on the distribution of soil texture. Managers and their publics are concerned with specific special species and their welfare. Individuals care about the welfare of their ownership. Inherent in all of these concerns is the question of how much detail is necessary, and the answers are different for each area of science. Atmospheric scientists, hydrologists, ecologists and economists are each pursuing the scaling issues within their discipline or, in some cases in interaction with one or two other disciplines, eg atmospheric scientists and ecologists, hydrologists and

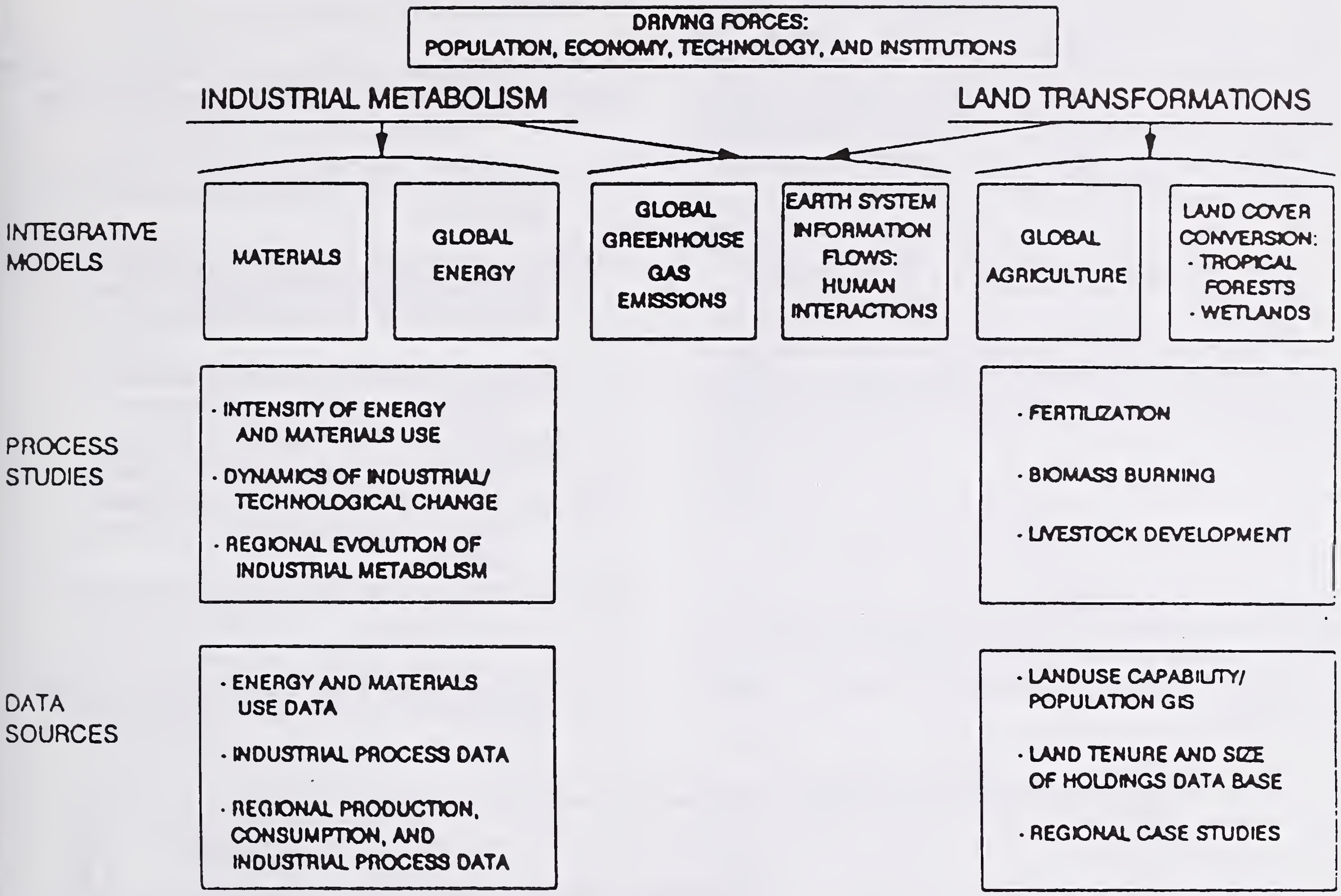

Figure 2. — Human sources of global change.

economists, etc.. There is a significant need to study scale for the broad range of disciplines involved. One approach to this is to simply construct interactions by linking between models in each of the disciplines. There is considerable research ongoing along this line of attack, fostered by the global change program and others. We plan to create a model complex that facilitates the incorporation of broadly different models developed by different disciplines but linked by their relationship to a geographic region. The Modular Modeling Complex (MMS) (Leavesley et al 1992) is currently being tested as a prototype for the modeling complex. It is described more fully in the fifth section of this paper. MMS is a hydrologically based model system that is designed to accommodate models that integrate time dependent processes. It may not be appropriate to incorporate all models for all disciplines. Once the issue of linkage between modules is addressed questions with regard to the fine grained texture of model inputs and model resolution can be studied. Study of these questions will require detailed data and special studies. In the global change community, there are a number of field experiments designed to address such data requirements, e.g. FIFE, GEWIX, HAPLEX, etc.

Paradigm issues are more difficult to study. At this point we don't see any way to address this question other than empirically. To do this we feel it is necessary to create an environment where the different disciplines can come together, share their analysis paradigms and initiate work together. We feel this is most productive if done in the context of actual realistic regional analysis. Regional analysis, as used here, means a comprehensive analysis of interactions between the physical/chemical/biological (PCB) system and the Socioeconomic and Stakeholder system (SES). By it's nature such an analysis requires a broad array of physical and biological scientists interacting with economists and other social scientists to define the behavior of the system. However, a broad array of scientists are not sufficient to conduct a meaningful regional analysis. The knowledge base of the scientists needs to be supplemented with the knowledge of other individuals who work directly with the land, either as owners of the land and it's resources, managers of publicly held land and resources or as regulators ensuring environmental quality. These "stakeholders" and their knowledge and concerns must be considered in any regional analysis. Because there is so broad an array of

"actors" in the regional analysis stage, TERRA's initial focus is on developing collaboration and on providing a decision support environment (equipment, software, and methodologies). TERRA plans to bring scientists, stakeholders and government agencies together to jointly formulate, develop and apply integrated ecosystem models for use in regional analysis. The manner in which we envision doing this is described in the next section.

STRUCTURED ANALYSIS OF SYSTEMS

The structured analysis of systems simply means a rational and repeatable problem solving approach. TERRA has captured the elements of this in its Decision Analysis Methodology (DeCoursey et al 1993). The TERRA DAM, illustrated in Figure 3, consists of a number of elements, designed to implement a structured analysis of ecosystems. It includes; a structured approach to analysis of the impacts of actions or decisions, collaboration technology with groups of scientists, managers and stakeholders, working with geographic information system platforms for the analysis and, conducting the analysis using a modeling complex including a comprehensive systems of models and modules.

Structured Analysis

A structured approach to the analysis of regional ecological systems consists of the steps outlined below:

1. IDENTIFY AND DEFINE AN ACTION OR DECISION:

2. INITIATE TEAM(S) TO DO INITIAL ANALYSIS OF THE PROBLEM:

   - Use Geographic Information System to define the geographic and temporal dimensions of the issue,
   - Determine potential physical, chemical and biological impacts of the changes caused by implementation of the action or decision.
   - Identify stakeholders potentially affected by the decision.

3. GATHER AN INTERDISCIPLINARY GROUP OF SCIENTISTS AND STAKEHOLDERS:

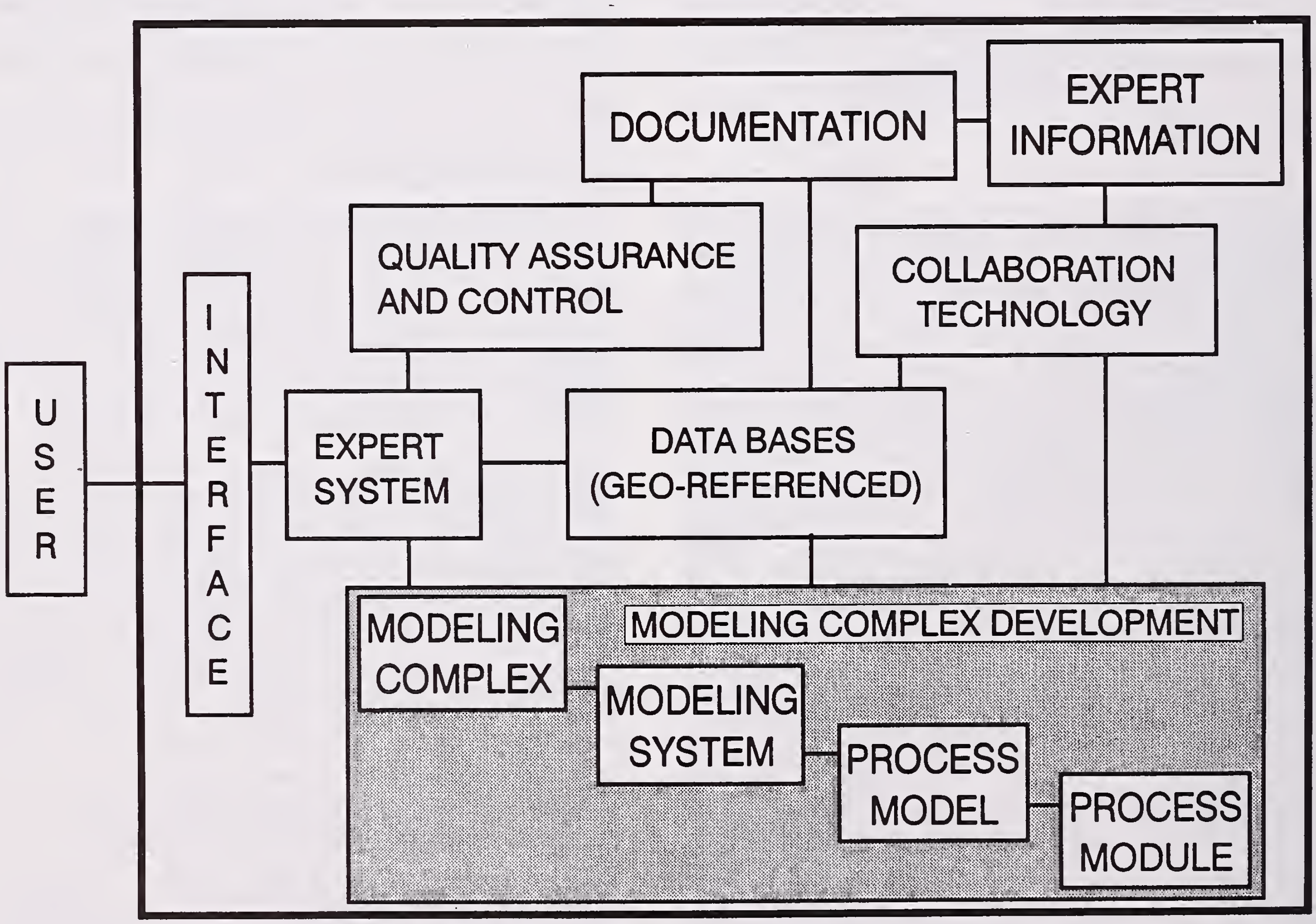

Figure 3. — Decision analysis methodology.

- Verify the initial consideration of the impacts and constraints of the proposed decision,
- Define a conceptual system structure including relationships and influences among system components and subcomponents (use model structure visualization tools).

4. DEVELOP A FORMAL MODEL (use TERRA Model Complex) TO REPRESENT THE SYSTEM DEFINED BY THE GROUP ABOVE:
   - Determine available models or modules,
   - Integrate existing modules into an interacting framework of model building blocks (TERRA Model Complex),
   - Populate databases needed for the analysis,
   - Resolve data and scaling issues.

5. RECONVENE THE TEAM TO EXERCISE THE SYSTEM MODEL:
   - Use interactive modeling system to construct various scenarios or alternatives (gaming),
   - Analyze the results of the simulations,

Collaboration Technology

Collaboration technologies are facilities, computers, and software programs designed to enhance convergence in interdisciplinary decision making and strategic planning. They facilitate working in a group environment, and enhance group productivity. Tools take the form of powerful computer workstations and personal computers (PC's) running software that simplifies loading, linking, visualizing, and applying ecosystem models. Procedures include new ways to work together through the use of computer and visual environments to maximize creativity in time-constrained working sessions. Meeting efficiency and effectiveness is enhanced using a work station and PC's linked to operate in a shared capacity so that data, models and information used in the meetings are group accessible.

It is well established that the use of teams to discuss issues or resolve conflicts can be extremely valuable, particularly when the teams include a broad spectrum of views and perspectives. Teamwork can encourage cross-fertilization of ideas and can lead to a broader ownership of the result of the group's efforts (Galegher and Kraut 1990). Group Decision Support Systems (GDSS) seek to enhance the power of teamwork by integrating supporting technologies. The rise of Decision Support Systems (DSS) over the past decade has established the power of supporting the decision maker with specialized computing power (e.g., spreadsheets, geographic information systems, computer aided design systems, etc.). However, these systems operate in a single-user, single-workstation mode. GDSS's provide the technology for supporting teams in the decision analysis process (Vogel and Nunamaker 1990). Integrating technology and teamwork can create more efficient team interaction, provide electronic meeting documentation, and allow group visualization of data and results. However, overuse of technology in a group setting might also weaken the inherent value of face-to-face interaction. For example, gestures are fundamentally important to communication, but gesture information is lost when computers are used as a communication medium (Grudin 1991). In addition, the use of computer systems as a "go-between" for participants may diminish the spirit of cooperation that is crucial between group members.

Geographic Information Systems Platforms

Another key component in structured group analysis of environmental issues is the use of a Geographic Information System (GIS) (Armstrong 1992). A GIS is a computer tool which supports the manipulation and visualization of spatial information (i.e. information which has historically been recorded on paper maps). GIS is used early in the analysis to give participants insight into the geographic bounds of a decision; this allows the group to visually explore spatial characteristics of an issue such as vegetation cover, population density, or drainage patterns. Ultimately, as models are finalized and the group is reconvened to examine simulated alternatives, GIS software will be used to visualize simulated impacts to the landscape. The use of GIS provides an integration theme for all the various and different disciplines involved in the work and a primary communication mechanism between them.

TERRA Modeling Complex

The TERRA DAM includes a modeling complex which both provides a framework for integrating existing models into a regional simulation system, and enables interactive exploration of alternatives and solutions. For early prototypes, TERRA is using MMS (Modular Modeling System), a cooperative development effort between CADSWES , USGS Water Resource Division, and TERRA. MMS is an integrated system of computer software that has been developed to support the development, linking, testing, and evaluation of hydrologic-process algorithms and to facilitate the integration of user-selected sets of algorithms into an operational hydrologic model. Even though the system is designed for temporally-sequential hydrologic model development, it is adaptable to many other models (plant growth, environmental, socio-economic). Models or

modules in the system reside on the shelf so to speak. The master library contains compatible modules for simulating water, energy, and biogeochemical processes. The modules consist of one or more subroutines and functions, with their feedback systems, to simulate a given process. System specific code declares and defines parameters and variables used by the module. A series of computer programs facilitates the inclusion of programs that do not now reside on the shelf. Both FORTRAN and object oriented programs (C++) can be incorporated into the system. Alternative conceptualizations of processes representing different time or space scales reside on the shelf so that models can be developed to fit specific situations or modules can easily be compared in a given situation. Statistical analyses are available in the system to aid in making decisions or comparing results.

MMS provides the framework for integrating existing models into a working system of building blocks, including the model data bases, parameter values, system states and conversion algorithms. MMS also provides a visual editor which allows a group to interactively construct simulation sequences from the model building blocks (Leavesley et al 1992). There is a broad range of model development in existence today under the auspices of the Global Change Program among others that should be used for regional impact simulation. The TERRA Modeling Complex will provide a framework for their use for this purpose. Models that will eventually be included in the Modeling Complex are briefly reviewed in the next section.

MODELS FOR REGIONAL ECOSYSTEM ANALYSIS

The research strategy of the US Global Change Program, a component of the scientific community's International Geosphere-Biosphere Program (IGBP), calls for research in four areas, Biogeochemical Dynamics, Ecological Systems & Dynamics, Climate & Hydrological Systems and Human Interactions. The modeling strategy, one of the cross cutting themes, recommended by the US committee suggests the need for development of "forcing" and "aggregation" modules as illustrated in Figure 4. Figure 4, however, has been modified to be more relevant to natural resource managers. The addition, of "Ecosystem Output Models" and, what TERRA calls "translation" modules, helps to recognize the role models play in the operational practice of land management, the subject of this symposium. Ecosystem Output Models are often, thought not exclusively, empirical in nature. They are well tested and validated for the conditions to which they are operationally applied. They generally do not accommodate climatic processes that would allow them to link into a climate change prediction scheme. Nevertheless they represent a considerable amount of

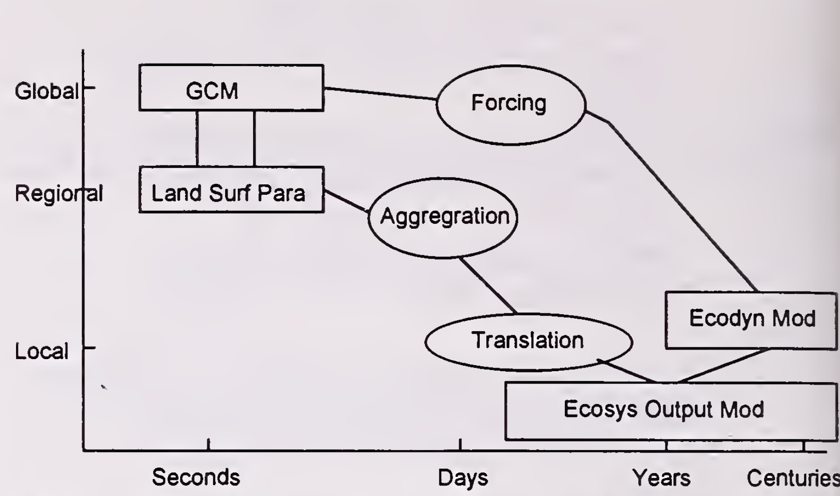

Figure 4. — Relationships among space, time, and model scales in global change.

accumulated wisdom. A key consideration for the global change research being conducted by land management agencies is how to utilize this wisdom.

The Terrestrial Ecosystems Regional Research and Analysis (TERRA) laboratory is approaching this problem from the bottom up. By gathering groups of stakeholders in the operational use of the Ecosystem Output Models along with the model developers, we are attempting to systematically study how to link these models into the process prediction constructions being developed by the global change research community. Regional pilot analyses of increasing complexity and scale provide a set of testbeds for proving the viability of this concept of linking models as well as testing its utility to the manager. TERRA hopes to provide a bridge between the operational management community and the global scale research community by doing this to their mutual benefit. The scientific detail of the TERRA approach and how it interlaces with Global change research programs is described in greater detail in this section.

The "translation" modules, as well as the aggregation modules shown in Figure 4 are actually linked models of the terrestrial system. But how are models to be linked, what processes need to be represented, and how are the vast scale transitions accommodated? These are questions that are being addressed, albeit in a somewhat different context, within the main body of the IGBP. The IGBP has developed two separate "Core" areas or scientific questions, that relate: (1) Biological Aspects of Hydrologic Cycles (BAHC) asking How does vegetation interact with physical processes of the hydrological cycle? and;-(2) Global Change and Terrestrial Ecosystems (GCTE) asking How will global change affect terrestrial ecosystems?

The USGC strategy suggests coupling successional models to biogeochemical models to physiological models in such a manner that full dynamic feedbacks between atmosphere and terrestrial systems are accommodated (CGC 1990). The research strategy they suggest recognizes a feedback loop between physical climate system driving changes in the state of ecosystems in turn affecting

biophysical and biochemical aspects which, in turn interact with the atmospheric system. This reflects the predominant interests of the large scale modeling community in terrestrial coupling. Ecosystem models, based on realistic mosaics of physiologically based process models, have been recently reviewed in detail (Nikolov and Fox 1993). They suggest that considerable research is needed in the coupling of photosynthetic processes with growth and assimilation processes for individual plants before the succession dynamics of communities can be accurately simulated. Figure 5 illustrates an idealized tree model structure.

VALIDATION AND FUTURE WORK

TERRA is conducting a series of pilot analysis projects to assess the effectiveness of the initial prototypes of the tools and methodologies described above. By conducting several pilot projects, TERRA hopes to validate its methodologies at both local and regional scales. The initial pilot analysis, which will focus on local scale issues, is being performed in cooperation with the Colorado River Headwater Forum (CRHF). The CRHF was established by the Northern Colorado Council of Governments to provide a forum for the discussion and cooperative resolution of issues related to water allocation in northern Colorado. Members of the CRHF include state, county, and local agencies, Federal regulatory agencies, industry, agriculture, and conservation/environmental interest groups.

TERRA is working with CRHF to study a water utilization issue related to the reclamation efforts of the Climax Mine, near Leadville, CO. The Climax Mine, owned and operated by the Climax Molybdenum Company, occupies a 12,000 acre site at 12,000 feet above sea level, astride the Continental Divide and at the headwaters of the Arkansas, Tenmile, and Eagle Rivers. The Climax Mine is an active participant in the Colorado River Headwater Forum.

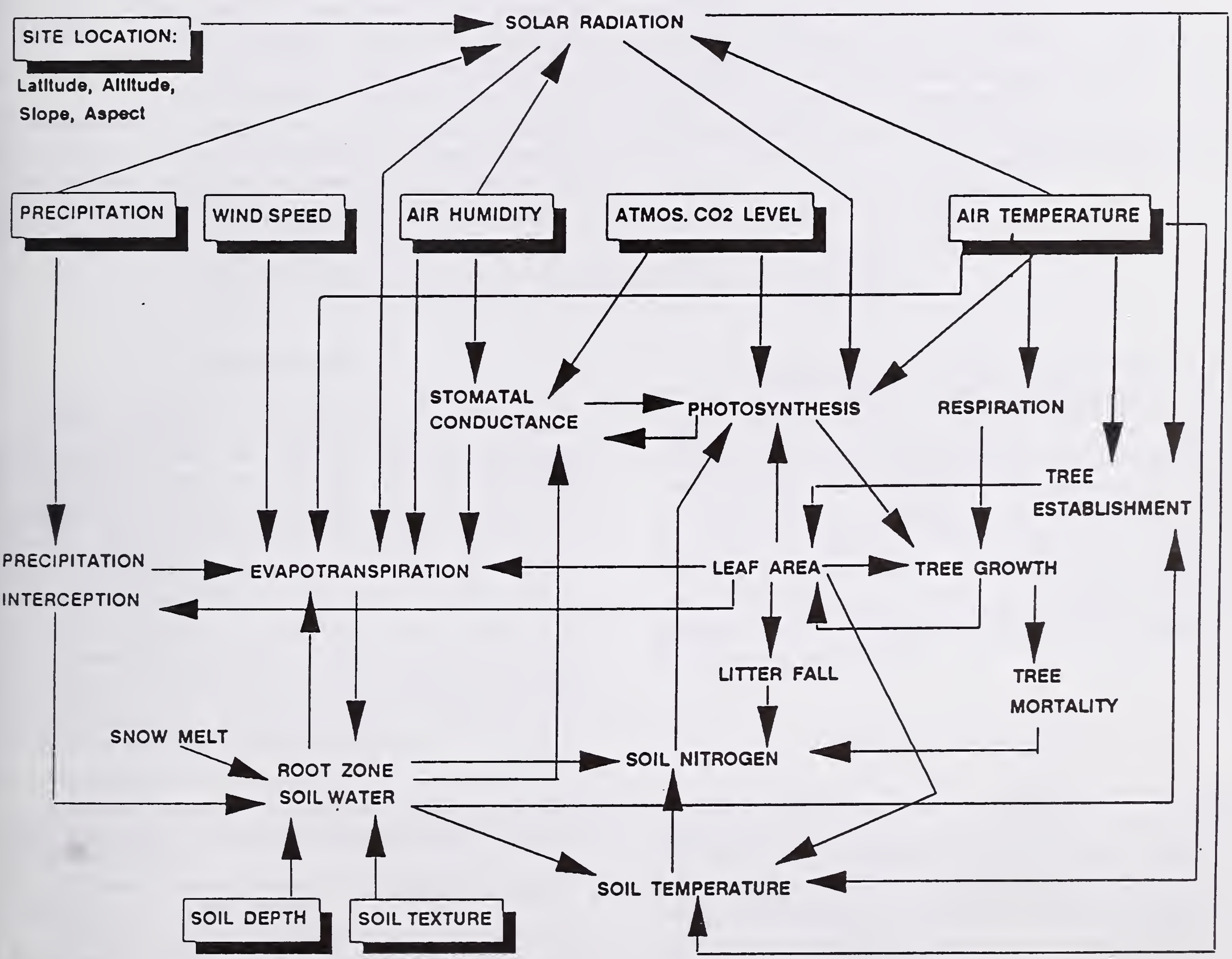

Figure 5. — Main parameters and processes controlling forest growth and demographic patterns in the TEMFES model. Arrows indicate interacting processes.

Climax Mine plans to convert a current tailing pond to a fresh water reservoir to be known as Eagle Park Reservoir, with a capacity of roughly 3000 to 28,000 acre feet. The TERRA decision analysis methodology is being used to evaluate the environmental, social, and economic impacts of executing this reservoir project, on a regional scale, as compared to identified alternatives for water sources, water diversion, and potential water customers. As part of the pilot analysis, TERRA is also considering the benefits of the Eagle Park Reservoir project under historically observed drought conditions.

A second, and rather larger scale problem that TERRA is considering for pilot analysis involves the Rio Grande/Rio Bravo Basin. This is a large multi-state/multi-country region which does not have a well-formed regional infrastructure, such as the Colorado River Headwater Forum described above, to develop policy and seek solutions to regional problems. TERRA will be working with a consortium of universities and governments in an effort to provide models and geo-referenced databases to address regional issues

There are other scales, both larger and smaller than represented by the pilot projects mentioned above, that require the type of broad technical analysis that TERRA can facilitate. As TERRA's program develops, we hope others with a more direct interest in these scales will join with us to conduct the analysis.

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Conservation and Sustainable Development of Encinal Woodlands: A Watershed Management Approach

Peter F. Ffolliott[1], Vicente L. Lopes[1], Carlos Esquivel[2], and Ignacio Sanchez Cohen[3]

Abstract — Encinal woodlands are a valuable environmental and economical resource for supporting natural systems and improving human welfare in the southwestern United States and northern Mexico. Noteworthy values of the encinals include wood and livestock production, wildlife habitats, watershed protection, and recreation and tourism. A key to sustaining these often fragile values lies in finding a balance between conservation and sustainable development. It is proposed that one way to attain this balance is through a "watershed management approach," which incorporates soil and water conservation, and land-use planning into a broader, logical framework. The integrated concepts of watershed management can provide a framework for conservation and sustainable development of the encinal woodlands, while watershed management practices furnish the tools for making the framework operational. Regulations, market and non-market incentives, and local investment opportunities provide the means for implementing the practices.

INTRODUCTION

Encinal woodlands, also referred to as the western live oak type in the Society of American Forester's classification (Ffolliott 1980) and the Madrean evergreen woodland formation (Brown and Lowe 1980, Brown 1982), are a valuable environmental and economical resource for supporting natural systems and improving human welfare in the southwestern United States and northern Mexico. Noteworthy values of the encinals include fuelwood and livestock production, wildlife habitats, watershed protection, and recreation and tourism. A key to sustaining these often fragile values, however, lies in finding a balance between conservation and sustainable development.

It is proposed that one way to attain this balance is through a "watershed management approach," which incorporates soil and water conservation, and land-use planning into a broader, logical framework for management. The integrated concepts of watershed management provide a structure for conservation and sustainable development of the encinal woodlands, while watershed management practices furnish the tools for making the framework operational. Regulations, market and non-market incentives, and local investment opportunities provide the means for implementing the practices.

REGION OF FOCUS

The region of focus is the encinal woodland communities in Arizona and New Mexico, USA, and Baja California Norte, Mexico. It includes large portions of Sonora, Chihuahua, and Durango, Mexico, and California, Nevada, and Texas, USA. Portions of Baja California Sur and Coahuila, Mexico, and Utah and Colorado, USA, also support encinals.

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The current knowledge on the ecology and management of encinal and associated woodlands was examined in a recent symposium on these topics, with perspectives presented from the southwestern United States and northern Mexico (Ffolliott et al. 1992). Invited papers summarized the research knowledge and management experience on ecology and silvicultural practices, growth, yield, and utilization potentials, livestock and grazing practices, wildlife habitat values, and hydrology and watershed management. Volunteer poster papers presented the results of research and case studies, and described management practices for multiple use values. Emphasis was placed upon technologies that bridge the gap between research and its application in the management of the woodland ecosystems.

LAND-USE PRACTICES

Many of these woodlands continue to be used as they were in the past. Selected trees are harvested for fuelwood, fenceposts, and other wood products. Grazing of livestock remains an important use. However, management is becoming more responsive to multiple use of woodland communities and local people's desires for these multiple benefits (Ffolliott and Guertin 1987, Ffolliott et al. 1992). The encinals are habitats for many wildlife species, some of which are endangered. The woodlands also are receiving increased recreational pressures. Land management practices, therefore, are evolving to encompass all of these demands. The trend of multiple use appears irreversible. It is for this reason that a watershed management approach to conservation and sustainable development has merit.

Wood Products

Processing of encinal tree species into wood products is important to the livelihood of many people. Fuelwood and fenceposts are two wood products commonly obtained from this primary resource. Other wood products that can be made from smaller, irregular stems and capitalize on unique physical characteristics of the species offer utilization opportunities for furniture and novelty items.

Livestock Production

One of the common uses of encinal woodland ecosystems is to provide the forage for livestock that graze these ranges. Situated between lower deserts and higher montane forests, the encinals frequently hold a key to balancing livestock numbers and forage resources. Compositions of livestock herds in the southwestern United states differ markedly from that in northern Mexico, however. A predominance of cattle is found in the former, while cattle and high proportions of sheep and goats graze in the latter (Downing and Ffolliott 1983). These differences are attributed largely to the economical and social-cultural orientations in the two countries.

Wildlife Resources

Wildlife resources in encinal woodlands have consumptive and non-consumptive values. In terms of consumptive use, management activities are centered on big game species and, to a lesser extent, on a variety of small mammals that are hunted. Wildlife management agencies in the southwestern United States and northern Mexico structure managerial strategies and action plans to obtain optimum levels of game production, consistent with other multiple use values. One non-consumptive value of importance is viewing of diverse and often unique bird populations. Opportunities for bird-watching bring large numbers of people into the region from outside areas, enhancing their recreational experiences.

Watershed Management

Encinal woodlands are not often thought of as watershed lands. However, water relationships in these ecosystems can be more important than those found in higher montane forests. Water is generally in critical balance in the encinals, and this balance frequently is upset by actions of people. Activities that are associated with watershed management programs include activities which are designed to minimize adverse impacts to soil and water resources, increase yields of high quality water, or bring a watershed from a "poor" condition into a productive state. Within these categories, watershed management practices are implemented to meet a number of conservation and developmental goals.

Recreation and Tourism

Recreation and tourism collectively represent one of the largest income generators from encinal woodland communities. On-site recreational opportunities include hiking, camping, sightseeing, bird watching, and picnicking. Comprehensive statistics on the levels of these non-consumptive uses are incomplete (Conner et al. 1990). For whatever the reasons, however, a growing number of people from both within and outside of the region are spending considerable time in enjoying the unique landscapes of the encinals.

CONSERVATION AND SUSTAINABLE DEVELOPMENT

It is appropriate at this point to state what is meant by conservation and sustainable development in this paper. Conservation has been defined and re-defined in light of the changing values that societies place on forestry and the management of natural resources. The early preservationists attitude was replaced by a concern for "wise use," and eventually conservation was defined in economical terms as the problem of securing an optimum allocation of natural resources through time (Gregory 1972). Attention has shifted again, and currently centers on problems of environmental quality. What end results this new concern about conservation will ultimately bring about is unclear, but it certainly will have an influence on forestry and the management of natural resources, and especially on the relative emphasis which managers will accord multiple use values.

Sustainable development can be defined arbitrarily either broadly or narrowly, although the definition should specify the time and space scales being considered (Brown et al., 1987, Conway 1985, Gregersen and Lundgren 1990). To be sustainable generally refers to long-term production of goods and services, with a minimum of resource depletion and environmental deterioration. To be sustainable also requires that the production of foods and services be both viable economically and acceptable socially. With sustainable development, food, fiber, and raw materials are provided in the "near-term" for today's populations, while natural resources are retained for the use of future generations of people.

It is felt that sustainable development of the encinal woodlands can be integrated with conservational concerns through a watershed management approach to land-use planning. It is proposed further that the important, often unique multiple use values of the encinals also can be accommodated by doing so. In other words, conservation and sustainable development in the encinal woodlands are not mutually exclusive managerial goals.

A WATERSHED MANAGEMENT APPROACH

At times, those responsible for management of the encinal woodlands have had difficulty in transforming their recognition of the importance of economical benefits and environmental effects into actions that improve the multiple use productivities for "targeted" publics and lead to tangible environmental benefits - both of which are needed in conservation and sustainable development. Taking a watershed management approach allows for the explicit accounting of environmental benefits associated with developmental projects, regardless of the multiple use values involved, and helps to identify the linkages between productivity increases and environmental changes over the long-term. The following definitions, taken from Brooks et al. (1991) and Gregersen et al. (1992), help point to the usefulness of this approach:

- A watershed is a topographically delineated area that is drained by a stream system, that is, a watershed is the land area above some point on a stream that drains past that point. A watershed is a hydrological unit that often also is used as a physical-biological unit and a social-economical-political unit in the planning and management of natural resources. A river basin is defined similarly but is larger. For example, the Colorado River Basin includes all lands that drain through the river and its tributaries into the Gulf of California.
- Watershed management is the process of guiding and organizing the uses of land and other resources on a watershed to provide the desired goods and services to people without harming soil and water resources. Interrelationships among land-use, soil, and water, and the linkages between uplands and downstream areas are recognized in this definition.
- Watershed management practices are those planned changes in land-use, vegetative cover, and other non-structural and structural actions that are taken to achieve specified watershed management objectives. As mentioned above, these objectives can be the protection of soil and water resources on lands being managed to produce food, fiber, forage, and other products of the land, enhancement of the supplies of high quality water, or rehabilitation of previously degraded watershed lands.

A watershed management approach, by its very nature, incorporates soil and water conservation, and land-use planning into a broader, logical framework by focusing on the following concepts (Gregersen et al. 1992):

- People are affected positively and negatively by interactions of water with other natural resources, and, in turn, people influence the nature and severity of these interactions by the ways in which they use the natural resources and the quantities they use.
- The effects of these interactions follow watershed boundaries, not political boundaries, that is, water flows downslope regardless of how managers define their boundaries of responsibilities. As a consequence, what is

done in the uplands of one managerial unit can affect another managerial unit occupying a downslope or downstream position on the watershed.
- Because these interactions cut across managerial boundaries, what can be sound use of natural resources from the point of view of one managerial unit may not be sound use of natural resources from the broader, societal point of view, because of undesirable downslope or downstream effects. The watershed management approach, therefore, brings externalities, or off-site effects, into the analysis by considering watershed boundaries.
- With the presence of externalities, ecologically sound management becomes good economics for all concerned only if the benefits and costs are distributed appropriately among the political units, communities, and individuals that carry out the watershed management practices and those that benefit from them.

The integrated concepts of watershed management provide a framework for conservation and sustainable development of the encinal woodlands, while watershed management practices furnish the tools for making the framework operational. Various institutional mechanisms, including regulations, market and non-market incentives, and public involvement, provide the means for implementing the watershed management practices.

A common misconception is that watershed management is based only on physical-biological interrelationships. However, the concepts presented above indicate that watershed management also involves economical and institutional interrelationships. These concepts also illustrate the focus of a watershed management approach and, as a consequence, can guide the design of the watershed management practices and institutional mechanisms needed to implement the approach on the ground.

A NEED FOR EFFECTIVE POLICIES

Academics and land management agency personnel often have discussed the concept of watershed management in the context of its being an integral part of forest management (Gregersen et al. 1992). However, when developmental projects are implemented, land management agencies rarely include watershed management practices, and when they do, the benefits and other effects rarely are quantified explicitly. So what difference does it make if one does or does not consider watershed management in developmental projects to be implemented in the encinal woodlands? It might be argued that watershed management is an issue that has little relevance in actual projects, because it cannot be implemented in practice for the following reasons:

- Urgent needs of the rural people living on watersheds for goods and services.
- Lack of appropriate institutions for the implementation of watershed management practices.
- The fact that watershed boundaries do not necessarily coincide with political boundaries.

These arguments can lead to short-term solutions and non-suitable land- use practices, if they are accepted. In addition, opportunities to enhance the welfare of the rural people in the long-term then can be lost. Effective policies are needed, therefore, that provide for conservation of soil and water resources in a manner that fits within a watershed management approach. A framework for studying the options of resolving policy issues related to watershed management and upland conservation and sustainable development has been developed to help in this regard (Gregersen et al. 1993).

OVERCOMING THE BARRIERS

The barriers to the wider adoption of a watershed management approach to conservation and sustainable development are being broken down slowly but surely (Gregersen et al. 1992). Most decision-makers concerned with how the encinals are used by people now recognize the imperative of environmentally sound conservation and sustainable development. Ignoring the boundaries and interrelationships set by the forces of nature will lead inevitably to serious, if not disastrous problems.

The challenge in strengthening the applications of a watershed management approach in the encinal woodlands of North American is not to change the world by replacing current land-use practices with some "magical" watershed management formula (Gregersen et al. 1992). Conservation and sustainable development within a watershed management framework does not mean populating the ecosystem with professional watershed managers who direct projects and control the activities of people living in a particular watershed. Nor does it mean establishing a large number of isolated watershed management projects. Rather, it is proposed that watershed management concepts and activities should be used mainly as integral components in forestry, livestock production, wildlife management, and related developmental projects.

These integral components have to be implemented and sustained by people other than professional watershed managers. General managers and administrators of developmental projects, foresters, hydrologists, range management specialists, wildlife managers, sociologists, and, most importantly, fuelwood cutters, ranchers and other users of the land also must become involved. The implication is

that all of these people need to understand and appreciate why and how watershed management should be incorporated into everyday activities.

Formulators of watershed management projects in the encinals of the southwestern United States and northern Mexico should consider questions such as these about the socio-economical and cultural settings for conservation and sustainable development (Gregersen et al. 1992):

- What are the indigenous abilities and potentials of the local people?
- How can the local people become partners in the planning and implementation of developmental projects?
- What are the institutional or regulatory factors that can change land-use practices?
- What is the history of the use of educational programs, subsidies, and other incentives to get changes in technology for a local area, the region, and the country?
- What infrastructure is present?
- How can developmental projects obtain the support of the local people?

The importance of a watershed management approach in achieving conservation and sustainable development must be recognized and actions taken to promote lasting changes toward environmentally sound land husbandry. Too often, watershed management practices initiated in developmental projects, not only in the encinals but also more generally, cease to function shortly after the project has been completed (Gregersen et al. 1992). Furthermore, the changes that can bring about improvement in human welfare should be extended beyond a project boundaries, so that people not involved directly with the project will be able to benefit. Although meeting the immediate needs of people is essential for humanitarian and political reasons, control of adverse impacts on the environment outside the project boundaries also is essential. All of these points represent the essence of conservation and sustainable development.

CONCLUSIONS AND RECOMMENDATIONS

Many of the following conclusions and recommendations have been stated earlier in a general context by Gregersen et al. (1992), but they are presented here in reference to a watershed management approach to conservation and sustainable development in the encinal woodlands of the southwestern United States and northern Mexico:

- Developmental projects directly affect the welfare of people in the uplands and downstream areas. Conservation and sustainable development, therefore, depends largely upon the adoption of watershed management practices by fuelwood cutters, local ranchers, and other land users who ultimately are the "true" watershed managers.
- Project planners always should consider the effects of upland development on water and sediment flows to downstream reservoirs, floodplains, and urban settlements. It is suggested that management agencies can estimate environmental impacts of developmental projects best by using a watershed management framework (Gregersen et al. 1987), which necessities appropriate expertise and involvement in the planning, implementation, and monitoring phases of projects.
- Expectations of benefits from upland watershed management practices by downstream interests need to be realistic. Implementation of watershed management practices on a small percentage of area on large watersheds will have incremental, but probably not significant downstream effects. Furthermore, naturally occurring phenomena, including soil loss and flooding, cannot be eliminated by changing land-use practices, although they likely can be mitigated in many cases.
- Development of appropriate watershed management practices depends largely upon the physical and biological characteristics of a watershed, that is, the structure of the woodland community and related ecosystem properties, climate, and topography, and the socio-economical conditions encountered, including the policy, institutional, and local settings.
- Large, complex, and multifaceted developmental projects can have limited success because of weak institutions and inadequate operational capacities. Therefore, mechanisms are needed to promote small-scale projects which seem to be more effective in getting the cooperation of local people. Efforts should be made to avoid unnecessary duplication and, more importantly, projects that are at cross-purposes.
- Management agencies should monitor and evaluate the environmental and ecological impacts of developmental projects more rigorously. After a project's appraisal, rarely do management agencies conduct enough monitoring or collect enough data to quantify the long-term watershed and other

environmental benefits that can be attributed to the project. More comprehensive monitoring, therefore, is needed.

To overcome barriers to the adoption of a watershed management approach in the encinals, the following steps are recommended:

- Translate public awareness of and concern over the unique multiple use values of the encinal woodlands into action.
- Help to strengthen the institutions responsible for the management of the encinals through better education, training, and extension of watershed management practices.
- Develop the operational capacities to implement watershed management practices where appropriate.
- Increase the emphasis on research efforts, especially those that help to identify and quantify the interrelationships of multiple uses of both land and natural resources.
- Increase the consideration of sustainability in the planning and management of developmental projects, giving explicit considerations to the issues of continuity, dissemination, and externalities associated with the project.

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LAS UNIDADES DE CONSERVACION Y DESARROLLO Y LA PRODUCION FORESTAL EJIDAL PARA LOGRAR SOSTENIBILIDAD

Jesús Ruiz Ramírez[1]

ANTECEDENTES DE ADMINISTRACION FORESTAL

PERIODO	TIPO DE ADMINISTRACION	ACCIONES PRINCIPALES
1926 - 1977	Servicio de Postulancia	-Un técnico, reponsable de los provechamientos en varios estados. -Acciones intracendentes.
1960 - 1977	Unidades industriales de explotación forestal	-Territorio indefinido. -Direccion técnica sujeta a la empresa consesionaria
1960 - 1977	Unidades de ordenación forestal.	-Territorio más definido y compacto. -No existia una continuidad y claridad en la prestación de servicios técnicos.
1978 - 1991	Unidades de administración forestal.	-Se establecen programas operativos de producción, protección fomento y apoyo. -Se sostienen con recursos aportados por los productores.
1991 a la fecha	Unidades de conservación y desarrollo forestal.	-Concesión de servicios técnicos forestales otorgada a dueños y poseedores, a profesionales técnicos y prácticos. -Recursos para operar en base a un programa pree-formulado por el propio concecionario.

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EFICIENCIA DE LOS SERVICIOS TECNICOS FORESTALES.

Los servicios técnicos al estar regionalizados por áreas compacta, facilita el manejo y control del recurso, lo que permite la prestación oportuna de los mismos, más completos y funcionales.

OBJETIVOS

- Proteger y fomentar el recurso silvícola y su contribución a la productividad alimenticia, al equilibrio ecológico y en general al desarrollo rural, bajo criterios de sostenibilidad.
- Promover el suministro constante y suficiente de bienes maderables y no maderables de calidad y precios adecuados el aprovechamiento optimo de los recursos (Bosques, caminos, organizaciones y financiamiento).
- Contribuir significativamente al bienestar socio- económico de las regiones silvícolas mediante la incorporación organizada y autosuficiente de los dueños y poseedores a las actividades de aprovechamiento e industralización.

CONSIDERANDO LAS ACTIVIDADES REALIZADAS DENTRO DE LA PRESTACION DE LOS SERVICIOS TECNICOS, LA EFICIENCIA SE HA OBTENIDO MEDIANTE LOS SIGUIENTES PROYECTOS BASICOS.

	Actividad
organizacion	- organizacion y administracion
	- organizacion para la produccion y apoyo a la socio produccion.
manejo	- Estudios de manejo integral
	- ajuste de estudios dasonomicos a manejo integral.
	- Cuencas hidrográficas
	- prevencion y mitigacion de impactos ambientales.
produccion	- Produccion maderable
	- incendios forestales
	- sanidad forestal
	- mejoramiento genetico

CONCLUSIONES

Posibilidades reales de lograr la sostenibilidad en los aprovechamientos forestales

- Las posibilidades son factibles para lograr la sostenibilidad en los aprovechamientos forestales realizandose una adecuada organización. ejecución y control de los aprovechamientos a traves de los servicios técnicos prestados considerando las las restriccones ecológicas vigentes.

Medidas que deben ser adaptadas de inmediato para lograr la sotenibilidad

- Hacer operativos técnica y economicamente los programas de manejo forestal.
- Buscar alternativas para la producción de otros recursos no maderables del recursos forestal.
  - producción de agua
  - produccion,rcreción, etc.
- Mejorar la infraestructura caminera e industrialde las áreas forestales.
- Mejoramiento tecnológico en las actividades de extracción y transporte, así como apoyo financiero para la adquicisión de tecnologia.
- Mayor participación de todos los sectores de la población en las desiciones del manejo forestal.

DENSIDAD DE POBLACION POR AREA

U.C.D.F.	Nº	SUP (Km^2)	POBLACION TOTAL	DENSIDAD DE POB. Nº. DE HAB POR (Km^2)
GUENACEVI	1	13'500.00	40,365	2.99
PAPASQUIARO	2	7764.33	32,455	4.18
Sn.MIGUEL C.	3	1,065.00	4,984	4.68
LA VICTORIA	4	1,822.12	8,528	4.68
EL HUEHUENTO	5	903.74	4,230	4.68
EL SALTO	6	5,279.88	25,713	4.87
OTINAPA	7	6,000.00	69,000	11.05
REGOCIJO	8	1,759.00	10,523	5.98
LA FLOR	9	5,320.00	20,695	3.89
MEZQUITAL	10	7,607.83	20,617	2.71
TEPEHUANES	11	5,721.46	15,047	2.63
TOPIA	12	2,849.68	20,147	7.07
GUENACEVI-T	13	4,335.32	13,309	3.07
T O T A L		63,929.11	285,613	4.84

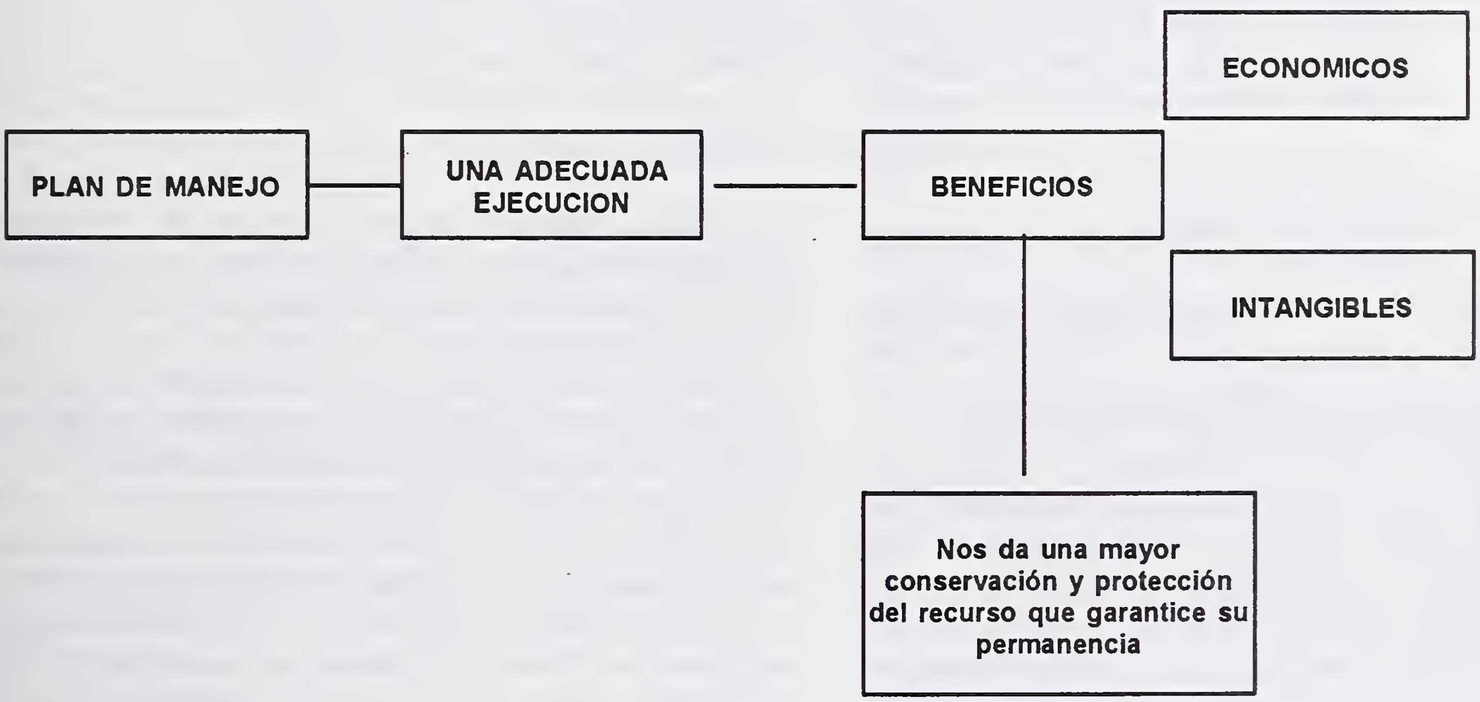
Necesidad de apoyo interinstitucional parta sumar esfuerzos de caracter ecológico productivo

- La coordinación interinstitucional se esta realizando de una manera adecuada entre las diferentes dependencias federales, estateles, y municipales, únicamente se requiere establecer los programas de manejo forestal bajo bases de equilibrio ecológico. obteniendo productos sostenibles.

Definir si es posibles pensar en el rendimiento sostenido y la presencia de los ecosistemas

- Todo lo anterior conlleva a definir la utilización y conservación del recurso existiendo una relación directamente proporcional.

Una planeación adecuada del manejo de todos los recursos forestales y no maderables, bajo dresrcicicones y medidas no preventivas de mitigación de impactos negativos, permiten el aprovechamiento sotenible dentro de cualquier ecosistema forestal.



PROBLEMAS LEGALES E INSTITUCIONALES DE LA SOSTENIBILIDAD

Abraham Escárpita Herrera[1] and Leonel Iglesias Gutiérrez[2]

Resumen.— Con los cambios realizados al Art. 27 de la Constitución Política de México y a las Leyes Agraria y Forestal, ya es posible desarrollar en nuestro país, programas de manejo y plantaciones forestales comerciales, que se ajusten a los principios técnicos necesarios para conservar el equilibrio de los ecosistemas que conforman nuestros bosques, y lograr de ellos, un rendimiento sostenido en volumen y calidad, que hasta la fecha y por razones de orden económico, cultural y legal, no hemos podido obtener.

INTRODUCCION

Los recursos forestales de México, son de tal magnitud, calidad y variabilidad, que son capaces de otorgar cosechas en volúmenes y especies suficientes para sostener una industria integrada que nos haga autosuficientes y permitirnos inclusive, asistir al mercado de exportación. Nuestros bosques de coníferas son de gran extensión y los tropicales tienen una diversidad de especies de gran calidad y belleza que alcanzan un excelente valor comercial.

La realidad sin embargo, es totalmente diferente: no somos autosuficientes; nuestras importaciones tienen un ritmo creciente ya sea en celulosa, papeles, triplay o simplemente madera aserrada. Por otro lado, el uso de los bosques esta lejos de encuadrarse en esquemas de manejo técnico que los hagan permanentemente productivos, no obstante que aunque estos se elaboren con sofisticados procedimientos y especificaciones ecológicas precisas, su aprovechamiento, en muchas ocasiones, resulta primitivo.

El "Plan Nacional de Desarrollo 1989 - 1994", formulado por el actual gobierno federal como guía y meta de su gestión sexenal, menciona en sus antecedentes que: "El país tiene una de las tasas de desforestación más altas del mundo, al mismo tiempo que una de las tasas de reforestación más bajas. Debemos detener urgentemente las prácticas irracionales que agotan nuestros bosques"

Estos conceptos, en el pensamiento de la máxima autoridad de nuestro país, y con la clara intención de frenar el mal manejo de nuestros bosques a través instrumentos básicos, dió margen a la elaboración y promulgación de una nueva ley forestal, que es la número cinco desde la primera publicada en 1926, así como la modificación al artículo 27 constitucional y la ley reglamentaria en materia agraria.

Estos cambios han permitido en algunos casos, la desaparición del tipo de propiedad ejidal, convirtiendo a sus poseedores en auténticos propietarios particulares y en otros casos, se autoriza la formación de asociaciones y/o contratación de terrenos ejidales con empresas particulares por períodos de tiempo hasta 30 años renovables, lo cual no era posible hacerlo con la anterior legislación. Esto es de gran significación en tratándose de terrenos forestales.

Se apunta que, hablando en términos generales, el 85% de los bosques de México están bajo régimen de propiedad ejidal y por el contrario, la gran industria forestal, pertenece casi en su totalidad a empresarios particulares quienes son simplemente, compradores de materia prima, ya sea en forma de trocería o madera aserrada, que es la única fase industrial a la que pueden aspirar los ejidos, en razón de su falta de capital y fuentes de finaciamiento suficiente y oportuno.

Esta condición, de que el ejido, dueño de los bosques, no tenga industria y de que los grandes industriales no tengan bosques ha sido la razón del desinterés y dificultad de manejar nuestros bosques a plenitud sobre la base de un rendimiento sostenido, invirtiendo en programas de

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conservación-plantaciones-caminos-industrias y equipos novedosos. Por el contrario se ha llevado a cabo una sobre-explotación sostenida.

ANTECEDENTES

El reconocido autor Kennet P. Davis, en su libro "Forest Management", hace una distinción de lo que es el manejo de los terrenos arbolados y terrenos forestales. De los primeros dice que son manejados para una multiplicidad de propósitos, con dominancia de uno de ellos, frecuentemente la producción de madera que puede ser dominante en una área en particular. Los terrenos forestales pueden ser manejados para diversos usos, algunas veces en la misma área y otras veces con usos dominantes asignados a áreas separadas. El manejo de toda el área esta dirigida a lograr los máximos beneficios netos totales. Un bosque manejado primariamente para producción de madera, puede frecuentemente y con, comparativamente pequeños ajustes, servir para cuencas, fauna o propósitos recreativos. En realidad, un uso mayor, bien administrado, usualmente asegura el de los demás.

Kennet P. Davis también habla de manejo para lograr un rendimiento sostenido y explica con toda claridad que "mucho se ha escrito acerca del rendimiento sostenido como el objetivo mayor del manejo de bosques, y que esto ha sido considerado algo así como una panacea. Consecuentemente, es importante entender, que el término tiene y al mismo tiempo no tiene, implicaciones relacionadas con la producción de madera". Sigue diciendo que "La productividad sostenida puede entenderse en dos formas: como la continuidad del crecimiento y como la continuidad de la producción o de la cosecha. La confusión viene porque las dos ascepciones no significan la misma cosa. Por ejemplo, un rodal con arbolado inmaduro, aún no comercial, puede estar siendo manejado por tener en ese momento un excelente incremento. El suelo esta empleado ciertamente en forma productiva y en ese sentido, se tiene una productividad sostenida (que debe entenderse como un crecimiento que se esta acumulando). Pero desde el momento en que el arbolado aún esta inmaduro, su cosecha principal se tendrá al futuro y ese rodal no esta produciendo una cosecha o corta sostenida en relación a su crecimiento.

En contraste, una zona forestal, que incluya rangos variables de clases de edad o de tamaño de los árboles, puede ser manejado como una unidad para obtener un flujo permanente de productos cosechados, así como para mantener un estado de producción constante desde un punto de vista de crecimiento sostenido.

En este libro, dice su autor Davis, "El rendimiento sostenido se aplica en su sentido literal que significa continuidad en la cosecha de una área forestal".

Por lo anterior y para efecto del presente trabajo, seguiremos entendiendo el concepto de rendimiento sostenido, exáctamente en los últimos términos expresados, con la adición y solamente por vía de aclaración de que, sin merma del capital bosque inicial.

También como antecedente y en razón del "V Congreso Forestal Mundial" celebrado en la ciudad de Seattle, en el estado de Washington en 1960, cuyo lema fue el "Uso Múltiple del Bosque", fue posible introducir dicho concepto dentro del lenguaje oficial de nuestra Secretaría de Agricultura, tratando de orientar el manejo de los bosques, ya no solamente a la producción de madera, sino también a los demás recursos conexos. Fue así como los pastos, el agua, la fauna y la recreación, comenzaron a formar parte inseparable de nuestra política forestal, en la misma forma que ahora, la ecología, se está convirtiendo en factor guía de todas las actividades de nuestra vida.

Lamentablemente, todos estos movimientos técnicos, políticos y sociales que tienen grandes repercuciones en los aspectos económicos, no pueden adoptarse ni adaptarse de inmediato sin causar diversas reacciones y trastornos, no obstante que están orientados a ofrecernos una mejor calidad de vida.

Es por ello que cuando se habla de aprovechar un recurso natural debemos tomar en cuenta no sólo el rendimiento sostenido de dicho recurso, sino también el equilibrio biológico del entorno en que este se desarrolla.

NUESTRA REALIDAD FORESTAL.

Durante la época de los 60's se llevó a cabo el Primer Inventario Forestal de México, usando para el efecto tecnología a base de fotografías aéreas, muestreos de campo de gran intensidad y presición y cálculos con ayuda de computadoras, proceso de gran novedad para aquellos años.

Fue así como se conocieron por primera vez y en forma oficial las características fundamentales de los bosques de México: especies, localización geográfica, superficie, volúmenes por hectárea y totales, incrementos, etc. Se identificaron las áreas forestales convertidas a agricultura o sea, áreas perturbadas; también las que en forma natural ostentaban pastizales y la

ubicación precisa de poblados, rancherias, caminos, etc. se tuvo en fin, un instrumento de gran valor para definir con la eficacia requerida, una política oficial que sentará las bases para una adecuada planeación del uso de los bosques y dimensionar las características de una industria, apropiada en tamaño a al productividad y calidad de los mismos.

Se proyecto en principio, el establecimiento de un ciclo de reinventarización de 10 años a fin de ir observando los cambios que se fueran produciendo por concepto de los volúmenes cortados con apoyo en los métodos de manejo aplicado, para, en todo caso, hacer los ajustes necesarios.

Se debe mencionar que a partir del inicio de este inventario y como consecuencia de los cambios sexenales de Presidente de la Republica, que llevan consigo cambios de funcionarios hasta los niveles de jefes de departamento y por consiguiente cambios en las decisiones de cualquier índole, han sido muchas las personas y de diferentes profesiones que han tenido en sus manos la conducción de la política forestal. Programas que se inician en un sexenio, se cancelan o modifican en el siguiente, perdiéndose o ganándose, según sea el caso. En relación al inventario, desgraciadamente, nunca se llevo a cabo el ciclo de re-inventarización según se había planeado.

Fue hasta 1991 -30 años después- que se llevó a cabo la formación de un mosaico forestal, integrado con la recopilación de la información de los estudios de manejo más recientes elaborados en todos los estados, como una forma de contar con un nivel de comparación que permitiera, al menos, tener una idea de la evolución de nuestros bosques en dicho lapso.

Dicho mosaico se conoce como "Informe Forestal de Gran Visión".

Si bien es cierto, los criterios seguidos en el primer inventario de 1962, difieren de los manejados en este informe, algunos conceptos pueden aceptarse como comunes y observar los cambios lógicos ocurridos en un lapso tan largo como el señalado de 30 años. Por ejemplo, a nivel nacional se observan las cifras de la Tabla 1.

Tabla 1.—Datos comparativos en trabajos de re-inventarización. Información relativa a la República Mexicana.

CONCEPTO (miles de hectáreas)	1962	1991	DIF	ANUA
superficie forestal	143,614	141,592	2,022	67.4
superficie perturbada	17,838	23,788	5,950	198.3
superficie arbolada	38,889	34,105	4,784	159.4
superficie de coníferas	18,681	16,961	1,720	57.3
volumen de coníferas (miles de m^3)	1,491,059	1,407,632	83,427	2780.9

El análisis de tan sólo los cinco conceptos de la Tabla 1 confirman lo expresado por el Presidente de la República en su "Plan Nacional de Desarrollo", en relación a la tasa de desforestación de nuestro país. La perturbación de cerca de 200 mil hectáreas cada año y la pérdida de 57,300 has. de coníferas, entre otras, deja ver una alteración ecológica de graves consecuencias, que evidentemente no obedece a ningún plan técnico de manejo, ni a ninguna disposición oficial, emanada de nuestra legislación, cuya filosofía básica esta orientada hacia el mejor cuidado y la mayor productividad de los bosques.

Si por otro lado, sabemos por estadísticas de la Subsecretaría Forestal, que los volúmenes de corta de coníferas en el período 1981-1991 tuvieron en promedio un volumen total anual de 7,762,709 m3 y al mismo tiempo el Informe Forestal de Gran Visión, ya mencionado, nos indica una reducción anual en el volumen total de coníferas de 2,780,900 m3, vemos que dicha pérdida representa el 35.8% de nuestra producción nacional, lo cual es francamente un evidente despilfarro.

Las cifras anteriores que se refieren a todo el país, se confirman con las que resultan en particular para el estado de Chihuahua, que es el que tiene la mayor superficie de coníferas y es el segundo productor de madera.

Con base en los mismos datos del Informe Forestal de Gran Visión y los obtenidos en el inventario de 1962, se tienen cifras significativas del cambio anual registrado en casi treinta años, citadas en la Tabla 2.

Tabla 2.—Datos comparativos en trabajos de re-inventarización para el estado de Chiahuahua.

CONCEPTO (superficie 1,000ha)	1962	1991	DIF	ANUAL
superficie forestal	16,134	15,553	581	19.3
superficie perturbada	700	976	276	9.2
superficie arbolada	5,100	4,949	161	5.3
superficie coníferas	4,161	4,027	134	4.4

En este caso particular del estado de Chihuahua, que no difiere mucho de lo que sucede en otros estados, y a fin de irnos formando un entorno mas real, del como se desenvuelve la actividad forestal, citaremos en la Tabla 3 los volumenes de madera que oficialmente se tienen registrados como cortas autorizadas en el periodo 1981-1991.

Tabla 3.—Estado de Chihuahua. Volúmenes de corta registrados en diez años.

AÑO	VOL. M3
1981	2,091,000
1982	2,050,000
1983	2,168,000
1984	2,252,000
1985	2,155,000
1986	1,918,000
1987	2,016,000
1988	1,755,000
1989	1,622,000
1990	1,589,000
1991	1,391,000
X = 1,909,000	

Observando el último valor reportado de 1991, y comparándolo con el volumen de corta promedio de ese período de 11 años, vemos que es inferior en un 27.1%, lo caul es realmente preocupante desde cualquier punto de vista que se le juzgue.

Si adicionalmente observamos la composición de los volúmenes de corta que hasta no hace muchos años estaba orientada y esto ordenado por disposición de la propia autoridad forestal, hacia el aprovechamiento de árboles de 35 cms. de diámetro y mayores, se confirma la dramática reducción de los árboles adultos, ya que con los que

actualmente existen, no es posible sostener una cosecha en forma permanente e igual, en volumen y calidad, a la de años anteriores.

La información oficial de la Sub-delegación Forestal en el estado de Chihuahua, nos indica que el volumen de corta autorizado para 1992, fué como lo indica la Tabla 4.

Tabla 4.—Distribución de volúmenes de corta por categoría diamétrica.

DIAMETROS (cms.)	VOLUMEN (M3 R.T.A.)	%
10 - 30	750,038	44.1
35 y +	948,202	55.9
	1,698,240	

Las cifras anteriores nos dejan ver que:

1. El volumen total autorizado sigue siendo inferior a la media de los volúmenes de corta del período mencionado (1981-1991).

2. Solamente el 55.9% del volumen autorizado tiene dimensiones propias para asierre, al menos para una operación industrial que resulte económica.

3. Los árboles de 10 - 30 cms de diámetro, cuya corta se autoriza, pudiera entenderse como resultado de trabajos silvícolas de aclareo, pero en todo caso, deberían ser adicionales a los volúmenes de asierre que forman la corta principal.

4. La conjunción de estas cifras con la desaparición de las 4466 has de bosque de coníferas que se registran anualmente y que se mencionaron anteriormente, nos expresan la imposibilidad de pensar en un manejo bajo el concepto de rendimiento sostenido.

5. Sin embargo, y de acuerdo con la definición que nos expresa Kennet P. Davis sobre este mismo asunto, debierá pensarse que estos bosques pudierán encuadrarse bajo dicho concepto ya que siguen produciendo una cosecha anual aparentemente de igual volumen pero integrada con árboles de diferente calidad, resultando por lo tanto, un ingreso diferente e inferior, por lo que, ya no son cosechas iguales y por lo mismo, no existe una producción sostenida.

NUESTRA LEGISLACION

La Constitución Política de los Estados Unidos Mexicanos, precisa en su artículo 27, lo siguiente: "La propiedad de las tierras y aguas comprendidas dentro del límite del territorio nacional corresponde originalmente a la nación, la cual ha tenido y tiene el derecho de transmitir el dominio de ella a los particulares constituyendo la propiedad privada".

Seguidamente establece que : "La nación tendrá en todo tiempo el derecho de imponer a la propiedad privada las modalidades que dicte el interés público, así como el de regular, en beneficio social, el aprovechamiento de los elementos naturales susceptibles de apropiación" "En consecuencia, se dictarán las medidas necesarias para ordenar los asentamientos humanos y establecer adecuadas provisiones, usos, reservas, y destinos de tierras, aguas y bosques" "Para disponer, en términos de la ley reglamentaria, la organización y explotación colectiva de los ejidos y comunidades:" "Para el fomento de la agricultura y para evitar la destrucción de los elementos naturales y los daños que la propiedad pueda sufrir en perjuicio de la sociedad".

Por su parte, la ley agraria, que es reglamentaria del artículo 27 constitucional, menciona en su artículo 5o. "Las dependencias y entidades competentes de la administración pública federal fomentarán el cuidado y conservación de los recursos naturales y promoverán su aprovechamiento racional y sostenido para preservar el equilibrio ecológico".

Finalmente, la nueva ley forestal señala en su "Artículo 1o. la presente ley es reglamentaria del artículo 27 de la Constitución Política de los Estados Unidos Mexicanos en materia forestal, es de observancia general en todo el territorio nacional, sus disposiciones son de orden público e interés social y tienen por objeto regular el aprovechamiento de los recursos forestales del país y fomentar su conservación, producción, protección y restauración.

Las normas a que se sujetará el aprovechamiento de los recursos forestales del país y las medidas de fomento que se adopten, tienen la finalidad de:

I. Conservar, proteger y restaurar los recursos forestales y la biodiversidad de sus ecosistemas.

II. Proteger las cuencas y cauces de los ríos y los sistemas de drenaje natural, así como prevenir y controlar la erosión y procurar su restauración.

III. Lograr un manejo sostenible de los recursos naturales maderables y no maderables, que contribuya al desarrollo socio-económico de los ejidatarios, comuneros y demás

propietarios, y poseedores de dichos recursos, sin reducir la capacidad de la naturaleza para regenerarse".

Los tres instrumentos juridicos mencionados: la Constitución Política de los Estados Unidos Mexicanos, la Ley Agraria y la Ley Forestal, tienen una profunda filosofía que impulsa y protege el uso y manejo de los recursos naturales y pone especial énfasis en la condición de sustentar su aprovechamiento, bajo la base de una producción permanente y sin deteriorar el ambiente ecológico en que se encuentran.

Por otra parte, se cuenta también con la "Ley General del Equilibrio Ecológico y la Protección al Ambiente" cuya finalidad fundamental y como su mismo título lo indica, es el cuidado de los ecosistemas, atender problemas de contaminación y del aprovechamiento racional de los elementos naturales de manera que sea compatible la obtención de beneficios económicos con el equilibrio de los ecosistemas, etc.

Sin embargo y no obstante el espíritu de estas leyes, la realidad es completamente diferente. Ya vimos, con base en información de la propia autoridad forestal, que los bosques están en franco deterioro en todos sus aspectos: superficies, volúmenes y productividad. Si los volúmenes de corta anual se han venido sosteniendo más o menos en las mismas cantidades, ha sido en base a tomar parte del capital productor y no únicamente el volumen del incremento. Por lo mismo, el volumen de crecimiento anual, ha dejado de ser permanente rompiéndose así el concepto de rendimiento sostenido.

Por lo mismo, el fantasma del desequilibrio ecológico se hace presente con todas sus consecuencias colaterales: aceleración de las corrientes de aguas pluviales, erosión, azolves de obras hidráulicas, fuga paulatina de la fauna, cambios climatológicos, etc. etc.

CAUSAS DE INSOSTENIBILIDAD DEL ECOSISTEMA

De Orden Social

La complicada constitución biológica de los bosques, sus grandes extensiones y su lejanía de los centros de población, hacen de ellos un recurso difícil de manejar y precisa que se le conozca con profundidad para establecer y lograr su permanente productividad.

Ya dijimos que el 85% de los recursos forestales de México, son propiedad de los ejidatarios, quienes viven dentro o en sus proximidades.

La marginación social y cultural en la que se encuentra la gran mayoría de la población rural, principalmente de los bosques, en donde la carencia de servicios es notoria, ha sido una tremenda limitante en contra del desarrollo forestal sostenible. La decisión oficial de años pasados para formar ejidos forestales a fin de elevar el nivel de vida de muchos solicitantes de tierras, fue una grata sorpresa para ellos, ya que de golpe y porrazo se encontraron con una riqueza que nunca crearon y que requería -aparentemente- que sólo se le cortara y vendiera, ya fuera por ellos mismos o por particulares, en base a contratos anuales, que era lo único que permitía la anterior Ley de Reforma Agraria.

La falta de sentido administrativo de los ejidatarios era totalmente evidente, así como de una adecuada organización en la población ejidal que permitierá el desarrollo equilibrado y completo de todas las fases del trabajo de aprovechamiento de sus bosques. En muchos ejidos surgieron de inmediato, graves disputas por realizar las operaciones más faciles y mejor remuneradas, como es el caso de las operaciones de transporte de la madera. Sin embargo, las de corta, troceo, arrastre y carga, se dejaban para ejidatarios de menor jerarquia. Inicialmente, las dos últimas operaciones: arrastre y carga, se realizaban a base de animales.

Fue así que, por el hecho de haberse convertido en dueños del recurso y la aparente impunidad de que gozaban para su aprovechamiento, así como la posibilidad de cortar árboles fuera del control técnico y venderlos al margen de la ley, dió como resultado el inicio de un desequilibrio no sólo de los bosques sino también del mercado que adquiría dichos productos a un precio más bajo.

Por otra parte y tomando en cuenta que la formación de los ejidos forestales no obedecio a una correcta planeación, en donde se haya tomado en cuenta la calidad y extensión de los bosques con respecto al número de solicitantes a fin de lograr una distribución equitativa, dió como resultado que haya ejidos muy pobres que escasamente producen un metro cúbico de madera por ejidatario por año, mientras otros producen más de 250 m3 por ejidatario y por año también, cuyo aprovechamiento y venta les permite ingresos razonables en forma permanente.

Esta desigualdad dió margen a inconformidades de los más desfavorecidos que son la mayoría, y desde luego al desarrollo de cortas clandestinas y desgraciadamente, al inicio de cultivos de estupefacientes como son la mariguana y la amapola como una forma de completar los ingresos que los ofrezca un mejor nivel de vida. Al mismo tiempo y de acuerdo a la verdadera vocación ancestral de esta población, que es la agricultura, no pocas son las áreas arboladas -las más planas y de mejor calidad- que todavía siguen siendo desmontadas para dedicarlas a dicha actividad. Nuevamente, la falta de conocimientos más o menos técnicos, de como lograr rendimientos económicos atractivos y conservar la

Tabla 5.—Datos relativos a Población y educación de La República Mexicana.

NUMERO DE HABITANTES

1970..........48,225,238
1980..........66,846,839
1990..........81,140,922
INCREMENTO MEDIO ANUAL = 3.4

EDUCACION:
analfabetismo de la población de 10 años y más.....15.11%
población de 15 años y más, sin instrucción........16.83%
población de 15 años y más con primaria incompleta.32.31%
población de 18 años y más sin enseñanza media.....72.91%
población de 6-14 años que no asiste a la escuela..30.37%

fertilidad de dichas tierras ha dado lugar a su abono en lapsos relativamente cortos, para seguir con la misma destrucción en bosques vecinos, inicialmente de mejor calidad.

Una idea numérica de las condiciones socio-culturales de nuestra población, se refleja en los datos de la Tabla 5 del censo de 1980, elaborado por el "Instituto Nacional de Estadística, Geografía e Informática" (INEGI).

Las cifras de la Tabla 5., que se refieren a todo el país incluyendo las grandes ciudades, no dan una idea exacta de las peores condiciones en que se desenvuelve la población rural, ya que ésta enfrenta condiciones más adversas y de difícil solución. La lejanía de los principales centros de población, la falta de caminos, la insalubridad, el clima riguroso, etc. hace difícil la presencia de programas permanentes de mejoramiento socio-culturales, económicos, de salubridad y otros.

Si alguien me preguntara sobre la posibilidad de recuperación de lo que se ha perdido, yo respondería que tal vez eso fuera posible en los próximos 50 años, siempre y cuando en este momento se suspendieran todas las actividades destructivas que se han descrito.

De Orden Económico.

Es bien sabido que el cultivo forestal, es un cultivo a largo plazo. El crecimiento de sus árboles en el caso de las coníferas, es demasiado lento en comparación con algunas especies de hojosas que se cultivan en las áreas tropicales, por ejemplo.

Grandes extensiones de bosques, principalmente en el norte del país, aparentemente ricos y productivos, donde el clima y el suelo no son muy favorables para un desarrollo vigoroso, apenas si ofrecen pequeños volúmenes de corta, en razón de que sus crecimientos son del orden del 1.0 al 2.0% promedio y con volúmenes por hectárea muy bajos cuya extracción es muy costosa. La lejanía en muchos de los casos y la falta de verdaderos caminos es un verdadero obstáculo para quienes se dedican a esta actividad. Complementariamente, las operaciones de aprovechamiento forestal: apeo, troceo, arrastre, carga y transporte, requieren de equipos especializados y de gran costo que significan fuertes inversiones. La maquinaria para pocesar la trocería en cualquier producto final, es aún más costosa y demasiado especializada en su uso y mantenimiento, principalmente para gentes que nunca antes pensaron en ser dueños de bosques y más que nada, carentes de recursos económicos para establecer una industria de este tipo.

Al no contar con el capital necesario para convertirse en industriales, hubieron de vender sus árboles en pie a particulares, en los volúmenes autorizados por la Secretaría de Agricultura durante los años de aprendizaje y lograr algo de capitalización, después de los cuales, muchos ejidos iniciaron su propia industria con financiamientos de los propios compradores y de algunas instituciones de crédito.

Sin embargo, estas pequeñas industrias -salvo unos cuantos ejidos- no han pasado de la fase de asierre, muchos de los cuales adquirieron equipos viejos, los que mal manejados, les producen grandes desperdicios y productos de mala calidad.

Todas estas condiciones tan desventajosas en el manejo de nuestros bosques ejidales, se han ido reflejando en forma paulatina pero persistente, en un abatimiento de sus existencias, según lo reflejan los resultados de los inventarios de 1962 y 1991.

De Orden Organizacional

La Ley de Reforma Agraria establece en los siguientes artículos, algunos conceptos que resultan importantes para comprender la problemática que enfrentan los ejidos en su administración:

> "Art. 32. El comisariado ejidal es el órgano encargado de la ejecución de los acuerdos de la asamblea, así como de la representación y gestión administrativa del ejido. Estará constituído por un Presidente, un Secretario y un Tesosrero, propietarios y sus respectivos suplentes."

> "Art.33. Son facultades y obligaciones del comisariado: I.Representar al nucleo de población ejidal y administrar los bienes comúnes del ejido, en los términos que fije la asamblea, con las facultades de un apoderado general para actos de administración, pleitos y cobranzas."

> "Art.35. El consejo de vigilancia estará constituído por un Presidente y 2 Secretarios, propietarios, y sus respectivos suplentes."

"Art. 36. Son facultades y obligaciones del consejo de vigilancia: I.- Vigilar que los actos del comisariado se ajusten a los preceptos de la ley y a lo dispuesto por el reglamento interno o la asamblea.

II. Revisar las cuentas y operaciones del comisariado a fin de darlas a conocer a la asamblea y denunciar ante ésta, las irregularidades en que haya incurrido el comisariado."

"Art. 39. Los integrantes de los comisariados y de los consejos de vigilancia durarán en sus funciones tres años."

Cabe mencionar, que la gestión administrativa de las autoridades ejidales, se realiza en base a una asignación económica que resulta de suma codicia, principalmente en ejidos con grandes volúmenes de corta, independientemente de la personalidad que como máxima autoridad adquiere dentro de su comunidad. Lo anterior da lugar a la formación de grupos antagónicos que esperan con ansia el tiempo de cambio de autoridades ya que la selección se realiza por votación de los ejidatarios.

Desafortunadamente, cuando las autoridades en turno apenas están aprendiendo a conocer el manejo de sus recursos, su cambio obligado a los tres años, dará lugar a la presencia de nuevos directivos que probablemente desconozcan de negocios y comience un nuevo ciclo de errores, aprendizaje y aciertos.

Lo anterior, dió lugar entre muchos otros razonamientos, ya sea de orden económico, social, político, ecológico, etc. a las modificaciones a la ley agraria que ahora ya permite la participación de la iniciativa privada en el manejo y administración de los recursos naturales de los ejidos, mediante convenios y contratos a largo plazo, lo cual abre las puertas a inversiones particulares de posible recuperación en los tiempos que se autorizan. Ejemplo: "Art. 45. Las tierras ejidales podrán ser objeto de cualquier contrato de asociación o aprovechamiento celebrado por el nucleo de población ejidal, o por los ejidatarios titulares, según se trate de tierras de uso común o parceladas, respectivamente. Los contratos que impliquen el uso de tierras ejidales por terceros tendrán una duración acorde al proyecto productivo correspondiente, no mayor a treinta años, prorrogables".

"Art. 46. El nucleo de población ejidal, por resolución de la asamblea, y los ejidatarios en lo individual podrán otorgar en garantía el usufructuo de las tierras de uso común y de las tierras parceladas, respectivamente. Esta garantía sólo podrán entregarla en favor de instituciones de crédito o de aquellas personas con las que tengan relaciones de asociación o comerciales."

Con estas disposiciones, la administración de cualquier tipo de negocios en asociación con los nucleos ejidales, podrá llevarse por personal de reconocida capacidad profesional que no necesariamente sean miembros del ejido ni tampoco cambiarlos a tiempos obligados. Lo anterior podrá garantizar en diversas formas, la preservación del recurso de que se trate y permitir las inversiones por ejemplo, en trabajos de plantaciones forestales, que en el caso de las coníferas, el término de asociación de 30 años es suficiente para obtener una cosecha de árboles propios para celulosa. En tratándose de bosques tropicales, en ese mismo tiempo es posible producir hasta 5 cosechas para material celulósico también, con especies como el eucalipto.

Lo importante con estas modificaciones, que en algunos casos han llegado quiza muy tarde, ya que algunos bosques han resentido daños irreversibles y otros recuperables a largo plazo y alto costo, es que, de cualquier manera, se tiene ya, el instrumento legal que permita la planeación actual y futura bajo la seguridad de invertir en aquello que garantice un rendimiento sostenido y el equilibrio ecológico de los ecosistemas.

La voluntad política para establecer las condiciones y seguridad de llevar a cabo un racional aprovechamiento de los recursos forestales, esta plasmada en las reformas legales que se han venido mencionando y toca ahora a la gran industria: celulosa, papel, triplay, aglomerados, muebles, etc., realizar los convenios y asociaciones con quienes poseen el bosque, para asegurarse el abastecimiento de su materia prima en base a proyectos, inversiones, formas y tiempos de realización.

ESTABLECIMIENTO DE PLANTACIONES FORESTALES

Ya se mencionó, que la ley agraria establece el concepto de tierras ejidales de uso común y de tierras parceladas. Las primeras deberán trabajarse por el grupo ejidal en forma comunitaria y las segundas en lo individual por el posesionario. En ambos casos, es posible la asociación con particulares para la formación de empresas productivas con superficies tan amplias como sean las necesidades de dichas empresas, mediante la participación de tantos ejidatarios y particulares como sea necesario.

Para el establecimiento de plantaciones forestales, que requieren de superficies que dificilmente encontrará entre propietarios particulares y en todo caso, estarán en forma muy dispersa, será necesario recurrir a terrenos ejidales para, en forma conjunta, particulares y ejidatarios, integrar grandes bloques compactos con las superficies requeridas.

El procedimiento que ha hemos ensayado y con resultados satisfactorios es la contratación de terrenos meidante renta anual que se negocia de acuerdo a la ubicación, calidad y condición actual de los mismos.

En el caso de terrenos comunales, la contratación se realiza directamente con las autoridades ejidales, quienes previamente obtuvieron la aprobación de la asamblea. Hemos manejado contratos con pago de renta anual y con especificaciones diversas tales como: empleo prioritario de la mano de obra de la comunidad ejidal para todos los tabajos necesarios de desmonte, sub-soleo, producción de plantas, plantación, protección, etc. el pago de la renta puede ser semestral o anual. Sin embargo pueden esperarse solicitudes tales como la construcción de caminos y la comunicación de pequeñas rancherias, ciertas obras comunales, como introducción de energía eléctrica, telefonía, agua potable, etc. todo lo cual, es motivo de negociación con base en el importe de la renta.

Se han manejado también, algunas formas de asociación, otorgando a los propietarios de las tierras, una participación como socio de la empresa recibiendo dividendos al momento de la cosecha o con ciertas variables que les permita un ingreso inicial mientras llega el tiempo de corta para después cambiar o recibir dividendos en función de la productividad de la plantación.

Los primeros intentos que hemos hecho, se inclinan hacia el pago de una renta anual.

Lo más importante de todos estos cambios legales que hemos venido mencionando, es que los campesinos forestales de México, al sentirse ya no sólo usufructuarios, sino dueños absolutos de sus tierras y bosques, y comprobar la posibilidad de poderse asociar en diveras formas a la gran industria forestal, ellos mismos pueden llegar a ser, vía plantaciones o mediante el cuidadoso ejercicio y vigilancia del manejo de sus bosques, en valiosos elementos de protección de los ecosistemas o de la ecología en general, dentro de sus repectivas áreas. ¡No es lo mismo manejar una cosa prestada que una propia!.

TRATADOS DE LIBRE COMERCIO

La firma de los tratados de libre comercio que nuestro país ha firmado, tanto con la República de Chile que ya entró en operaciones en enero de este año, así como el de Estados Unidos y Canadá, aún no ratificado por los Congresos correspondientes, crearán situaciones de difícil pronóstico en el área forestal.

En el caso de Chile, país que esta en pleno proceso de establecimiento de extraordinarias plantaciones a base de pino radiata y también de eucalipto, con incrementos anuales que México está muy lejos de alcanzar todavía, se ha fijado una desgravación de aranceles, que ahorita es del 10%, pero que llegará a cero en solamente 4 años en la mayoría de los productos y de 5 años para los del sector agropecuario.

Por lo que respecta a los acuerdos a que se llegó con los Estados Unidos y Canadá, en materia forestal, se fijaron los plazos de desgravación expuestos en la Tabla 6.

La gran superficie arbolada de estos países, la integración industrial con que cuentan, la basta tecnología aplicada en todos los campos y sobre todo, su gran tradición forestal que se manifiesta por el cariño y cuidado con que manejan sus bosques hacen en ellos unos competidores, a quienes y ante la imposibilidad de igualarlos, bien pueden desplazar del mercado a los productores forestales mexicanos.

En los 15 años de plazo que se ha fijado para desgravar la madera aserrada, que es el mayor plazo en relación a los demás productos, no es suficiente para establecer en México condiciones de competitividad, no obstante que la iniciativa privada y desde este mismo momento iniciará su modernización y se asociará con los dueños de los bosques en los términos ya expresados.

Los volúmenes de inversión que requiere nuestra industria forestal son altisimos, principalmente en el renglón de caminos, así como en maquinaria y equipos para todas las fases del proceso silvícola e industrialización, y se duda que de repente sugierán grupos económicos capaces de sacar adelante una actividad con todos los atavismos que hemos venido mencionando.

Sin embargo, nuestro país debe realizar su mejor esfuerzo a fin de no caer en un intento de competencia, en un mayor abuso de sus bosques o por el contrario, en su abandono, consumiendo los productos de importación, que eventualmente serían más baratos y de mejor calidad.

Tabla 6.—Tipo de productos y tiempo de desgravación contemplados en el Tratado de Libre Comercio de América del Norte.

PRODUCTO	TIEMPO DE DESGRAVACION
hojas de conífera para chapa molduras aglomerados	inmediato
marcos de madera duelas puertas y umbrales	5 años
madera en rollo triplay muebles	10 años
madera aserrada	15 años

CONCLUSIONES

1. El manejo de los bosques debe estar orientado a satisfacer necesidades de la población en forma permanente, tanto en cantidad como en calidad y en armonia con los demás recursos asociados al bosque.

2. Por diversas causas, la silvicultura en México, está muy lejos de realizarse conforme a los principios clásicos del rendimiento sostenido y del equilibrio ecológico.

3. Existe sobre-explotación de las masas arboladas y un abuso en la conversión de terrenos forestales a zonas agrícolas.

4. La propiedad de los bosques de mayoría ejidal y una legislación inadecuada, ha impedido su manejo bajo conceptos técnicos que aseguren su permanente productividad.

5. Desfavorables condiciones económicas, culturales y de organización administrativa ejidal, han sido factores de fuertes impactos negativos en el manejo de los bosques.

6. Cambios recientes, tanto en la legislación agraria como en la forestal, abren amplios caminos y posibilidades de re-encauzar nuestra silvicultura sobre bases y conceptos de persistencia, permitiendo contratos de duración razonable y asociaciones que antes no eran permitidas. Los resultados sin embargo, se veran en el mediano plazo, en virtud de tratarse de un cultivo que precisade muchos años para manifestarse.

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ALGUNAS CONSIDERACIONES SOBRE LA ACTIVIDAD FORESTAL ANTE LAS REFORMAS DEL ARTICULO 27 CONSTITUCIONAL Y LAS LEYES REGLAMENTARIAS FORESTAL Y AGRARIAS

Abel López Caballero[1]

INTRODUCCION

Los terrenos rústicos de México pueden ser agrìcolas, ganaderos o forestales; desde el punto de vista jurídico estos terrenos se clasifican según la naturaleza de sus propietarios o poseedores, consecuentemente podemos identificar la propiedad pública, ejidal, comunal o privada.

El ejido y la pequeña propiedad son los sistemas de tenencia nacidos de la Reforma Agraria Mexicana, la propiedad común se restituye, puesto que los pueblos indígenas fueron despojados de sus tierras en la época de la colonia. Actualmente más del 70% de la superficie de tierras forestales es de propiedad ejidal y comunal.

En rigor jurídico forestal se crea en el código agrario promulgado el 23 de Septiembre de 1940. antes sólo había ejidos agrícolas; los pastos y los montes se dotaron solamente para satisfacer las necesidades domésticas de las familias campesinas.

Existen ejidos forestales en virtud de que poseen áreas arboladas suficientes y suceptibles de aprovechamientos forestales comerciales. Sin embargo, su creación ha sido con base al sistema agrícola y por lo tanto, el marco de juridico de los mismos no ha sido el adecuado. No es sino hasta la ley Forestal de 1986 y la actual; así como la ley Federal de la Reforma Agraria y la Ley Agraria actual, que estos instrumentos legales contienen disposiciones especificas legales ejidales y forestales.

Es importante señalar que no obstante las limitaciones jurídicas, ha sido con los ejidos y comunidades forestales en donde se han ensayado el mayor número (11) de tipos de organización campesina para la producción.

El presente trabajo pretende por una parte, analizar las disposiciones legales en relación a la actividad forestal y por otra, llegar a conclusiones que sugieran algunas medidas técnicas organizativas y operativas para lograr la sostenibilidad de la producción forestal.

LAS REFORMAS DEL ARTICULO 27 CONSTITUCIONAL DE IMPORTANCIA FORESTAL

Dentro de las reformas contenidas en el Décreto Publicado el 6 de enero de 1992, sobre las reformas del Artículo 27 constitucional, destacan en materia forestal:

1. Establecer adecuadas previsiones, usos, reservas y destinos de bosques(párrafo 3o).
2. Preservar el equilibrio ecológico (párrafo 3o).
3. La organización y explotación colectiva de ejidos y comunidades (párrafo 3o).
4. El fomento de de la silvicultura (párrafo 3o).
5. Evitar la destrucción de los elementos naturales (párrafo 3o).

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6. Las sociedades mercantiles por acciones podrán ser propietarias de terrenos rústicos pero únicamente en la extensión que sea necesaria para el cumplimiento de su objeto (Frac.IV).

En ningún caso las sociedades de esta clase podrán tener en propiedad tierras dedicadas a actividades forestales en mayor extensión equivalentes a 25 veces los limites señalados en la fracción XV del Artículo 27 (Frac. IV).

7. Se fortalecen la personalidad jurídica de los núcleos de población ejidales y comunales (Frac. IV).

8. Se protege las integridad de las tierras de los grupos indígenas (Frac. VI).

9. La ley regulará el aprovechamiento de bosques de uso común (Frac. VII).

10. La ley regulará el ejercicio de los derechos se los comuneros sobre la tierra y de cada ejidatario sobre su parcela (Frac. VII)

11. La ley establecerá los procedimientos para la asociación entre ejidatarios y comuneros, con el estado o con terceros y otorgar el uso de sus tierras (Frac. VII).

12. Se establece como pequeña propiedad forestal la superficie de 80 Ha. de bosque o monte.

LA LEY FORESTAL Y LA SOSTENIBILIDAD

De la ley forestal solo podemos considerar como disposición que se refiere especialmente a la sostenibilidad en lo siguiente:

Lograr un manejo sostenible de los recursos maderables y no maderables (Art. 1o Frac. III) . Además inciden en el proceso sostenible de un aprovechamiento . Cambio de uso del suelo (Art. 16) y los programas de manejo (Art. 12, Frac. II).

LEY AGRARIA - ARTICULOS DE IMPORTANCIA FORESTAL RELACIONADOS CON LA SOSTENIBILIDAD

Artículo 5° Las dependencias y entidades competentes fomentarán el cuidado y conservación de las reservas naturales y promoverán su aprovechamiento racional y sostenido.

Artículo 6° Las dependencias y entidades competentes buscarán establecer las condiciones para canalizar recursos de inversión y crediticias que permitan la capitalización del campo".

- Fomentar la composición de predios y parcelas en unidades productivas.
- Proporcionar todo tipo de asociaciones con fines productivos.
- Promover la investigación científica y técnica, así como la transferencia de sus resultados.
- Apoyar la captación, organización, asociación de productores, mejorar la producción, la transformación y comercialización.

Artículo 9° Los núcleos de población ejidales o ejidos tienen personalidad jurídica y patrimonio propio y sus propietarios de las tierras que les han sido dotados o de las que han sido adquiridas por cualquier otro título.

Artículo 11° La explotación colectiva de las tierras ejidales.

Artículo 23°

Fracción V. Aprobación de los contratos o convenios que tengan por objeto el uso o disfrute por terceros de las tierras de uso común.

Fracción IV. Autorización a los ejidatarios para que adopten el dominio pleno de las parcelas y la aportación de las tierras de uso común a una sociedad.

Artículo 45° Los contratos que impliquen el uso de tierras ejidales por terceros tendrán una duración acorde al proyecto productivo correspondiente, no mayor a treinta años prorrogables.

Artículo 46° El núcleo de población ejidal y la ejidataria en lo individual podrán otorgar en garantía el usufructo de las tierras de uso común y de las tierras parceladas.

Artículo 50° Los ejidatarios y los ejidos podrán formar uniones de ejidos asociaciones de interés colectivo y cualquier otro tipo de sociedades mercantiles o civiles para el mejor aprovechamiento de las tierras.

Artículo 74° La propiedad de las tierras de uso común es inalienable, inprescriptible e inembargable, salvo los casos...

El reglamento interno regulará el uso, aprovechamiento, accesos y conservación de las tierras de uso común...

Artículo 75° En los casos de manifiestas utilidades para el núcleo de población ejidal, éste podrá transmitir el dominio de tierras de uso común a sociedades mercantiles o civiles en los que participen el ejido o los ejidatario.

Artículo 108° Los ejidos podrán constituir uniones, cuyo objeto comprenderá la coordinación de actividades productivas, asistencia mutua, comercialización u otras.

"Las uniones de ejidos podrán establecer empresas especialidades que apoyen el cumplimiento de su objeto y les permita acceder de manera óptima a la integración de su cadena productiva".

"Los ejidos y comunidades, de igual forma podrán establecer empresas para el aprovechamiento de sus recursos naturales o de cualquier índole , así como la prestación de servicios".

Artículo 110° Las asociaciones de interés colectivo podrán constituírse por dos o más de las siguientes personas: ejidos, comunidades, uniones de ejidos y comunidades , sociedades de producción rural, o uniones de sociedades de producción rural.

"Su objeto será la intergración de los recursos humanos, naturales, técnicos, y financieros para el establecimiento de industrias , aprovechamientos, sistemas de comercialización y cualesquiera otras actividades económicas ; tendrán personalidad jurídica a partir de su incorporación en el Registro Agrario Nacional".

Artículo 111° Los productores rurales podrán constitutír sociedades de producción rural.

Artículo 119° Se considera pequeña propiedad forestal la superficie de tierras forestales de cualquier clase que no exceda de 800 ha.

Artículo 126° Las sociedades mercantiles o civiles no podrán tener en propiedad tierras agrícolas , ganaderas o forestales de mayor extensión que la equivalente a veinticinco veces los limítes de la pequeña propiedad individual.

ANALISIS

En materia forestal, las modificaciones al Artículo 27 constitucional tienen una importancia trascendental ya que por primera vez se eleva a rango constitucional el fomento de la silvicultura, lo que obliga a las leyes reglamentarias a regular con mayor énfasis esta actividad.

El cambio de esquema de tenencia de la tierra, de simple poseedor a propietario concede mayor seguridad al ejidatario aunque conlleve el riesgo de propiciar la venta fácil de tierras ejidales y crear verdaderos latifundios, toda vez, que las sociedades mercantiles podrán poseer hasta 20,000 ha., forestales. Sin embargo este hecho (contar con grandes superficies) facilita el manejo dasocrático y por lo tanto la permanencia indefinida de una explotación racional y/o una industria forestal.

En rigor el contenido de la ley Forestal debe enfocarse hacia la conservación indefinida de los recursos forestales , que como un recurso renovable no debería estar en riesgo de desaparecer o deteriorarse; también debe enfocarse hacia el rendimiento máximo sosntenido , a su uso múltiple y al fomento de los mismos.

La ley Forestal , como las ciencias forestales debe tender, siempre hacia el rendimiento sostenido . Sin embargo la ley forestal solo una vez menciona algo con respecto al rendimiento sostenido o sostenibilidad productiva , en la Frac. III del Art. 1o. que se refiere a "manejo sostenible".

La administración y manejo de refursos forestales, Título Segundo de la ley, y sus capìtulos I,II y IV en los uqe habla de inventario , zaonificación forestal , aprovechamiento, forestación y de los servicios técnicos forestales , no se menciona la sostenibilidad de la producción. Entendemos que la regulación de los aprovechamientos comerciales deben tener como meta la sostenibilidad de la producción. Entendemos que la regulación de los aprovechamientos comerciales deben tener como meta la sostenibilidad de la producción , permanencia, fomento y mejoramiento del recurso.

Dentro de la ley agraria, dos son los aspectos que inciden en la sostenibilidad de la producción . Por una parte , los contratos o convenios que los ejidos o ejidatarios celebren con terceros , podrán tener una vigencia hasta 30 años prorrogables, hecho que permite establecer y operar, sin problemas, los proyectos de ordenación forestal que son de largo plazo. Sin embargo habrá que encontrar mecanismos de manejo y aprovechamiento para que los dueños de bosques reciban los beneficios económicos con oportunidad y equidad.

Por otra parte, el derecho de asociarse o unirse en las diferentes normas o figuras lícitas, permite conjuntar áreas suficientes y compactas sin los problemas legales a los que se ha enfrentado la actividad forestal, permitirán un buen manejo forestal, el aprovechamiento racional y su rendimiento máximo sostenido.

Es importante hacer notar, que tanto la vigencia de los contratos como el derecho de asociación y de propiedad de las tierras , son armas de dos filos. Por una parte , favorece la explotación racional y el manejo forestal para sostener indefinidamente la producción, pero por otra propicia injusticias desde el momento de que la asociación con industriales o capitalistas en general es desigual en todos los aspectos, lo cual permite que estos obtengan ventajas sobre los ejidatarios y comuneros cuyos niveles sociales y culturales, son bastante modestos para enfrentar socios fuertes económica y culturalmente. por otro lado, el hecho de que los convenios duren hasta treinta años y prorrogables, favorece, mediante argucias legales, sujetar a dueños de los recursos forestales en condiciones que no pudieran ser más adecuadas.

Posiblemente, se desmotive también la organización productiva campesina, para realizar el aprovechamiento directo de los recursos naturales a través de las diferentes formas de organización que se han ensayado en la actividad forestal ejidal como son: las empresas ejidales, cooperativas, las sociedades locales de crédito, las unidades de producción, entre otras.

CONCLUSIONES

Tenencia de la Tierra.

El hecho de que el ejidatario sea dueño de su parcela y pueda venderla por razones de incosteabilidad o falta de recursos para hacerla producir , conlleva los riegos de:

A) Que los ejidatarios no tengan otro futuro más que de peones asalariados.

B) Se limita la posibilidad de ser productores y..

C) Se propicia la constitución de latifundios legales con superficies equivalentes a veinticinco veces la pequeña propiedad y simulados con superficie mayores a ésta.

Parece no quedar claro si los bosques son y deben ser tierras de uso común. El Artículo 59 de la ley agraria dice: "Será nula de pleno derecho la asignación de parcelas en bosques o selvas tropicales" y la frase "bosques o selvas tropicales excluye a los bosques de clima templado y frío , y por lo tanto, parece ser que estos, si pueden parcelarse, lo cual para el manejo forestal constituye un problema al tener que presentarse con un alto número de parcelarios , los que obligaría a abrir un alto número de áreas de corta , apertura de caminos y vías saca que dificultarían el manejo regional y elevarían los costos de producción.

Es importante hacer notar que la definición de pequeña propiedad forestal, no ha sido determinada en base a los estudios socio-económicos y técnicos que la justifiquen.

Contrataciones, Asociaciones, Uniones, etc.

Es loable el fortalecimiento del derecho de contratación y asociación que señalan , tanto la Ley Agraria como la Ley Forestal; actos que en materia forestal ya se venian concertando a través de los convenios de asociación en participación, contratos de compra-venta de materia prima entre otros, con vigencia de un año prorrogables. Con las nuevas disposiciones estos contratos tendrán una vigencia de treinta años prorrogables (Artículo 45 Fracción I Ley Agraria).

La experiencia ha demostrado que las asociaciones de ejidos comunidades y pequeños propietarios con productores o industriales forestales, salvo las exceciones del caso, han sido inequitativas en contra de los dueños o poseedores del recurso, puesto que la administración y la comercialización quedan en manos, siempre de los inversionistas asociados. por otra parte, las contrataciones por 30 años implican que la asociación se realice con el mayor de los cuidados, con buena fé y que no permita que los asociantes (ejidos, comunidades y/o pequeños propietarios) queden sujetos a condiciones desfavorables.

Sostenibilidad

Sí sostenibilidad es sinónimo de "rendimiento máximo sostenido", podemos concluir que es la meta de la dasonomía, puesto que se logra mediante la aplicación práctica de las ciencias forestales, biológicas, económicas y sociales. La Ley forestal solo mencionaría "manejo sostenible" término que a mi entender no correponde ni a la sostenibilidad de la producción ni el rendimiento máximo sostenido, puesto que el manejo sostenible no necesariamente implica rendimiento o producción sostenida o sostenible.

El nuevo esquema legal sobre tenncia de la tierra y el derecho de contratación a largos plazos favorece el manejo forestal y por ende, el rendimiento sostenido.

Unidades Industriales de Explotación Forestal (UIEF)

En México existe experiencia suficente y con magnificos resultados, sobre el manejo dasnómico de grandes superficies arboladas; el ejemplo lo son las extintas unidades industriales de Explotación Forestal, que en su tiempo constituyeron una aportación a la administración forestal mundial.

Creo conveniente , que con algunas modificaciones legales y técnicas a la constitución y operación de estas unidades , podrían ser la alternativa viable, para que la producción silvícola y la industria forestal del país , tome su lugar en la económia nacional, sobre todo ahora que el TLC requiere de productividad y competitividad, no solo dentro del ámbito nacional, sino también en el internacional.

Is "Sustainability" Synonymous With "Sustained Yield" on National Forest System Lands?

Charles B. Lennahan[1]

Abstract. — In discussing "sustainability", it is essential to know the context. Some of the factors that could be considered in defining the context and understanding the term are, "Is it a relative term or an absolute term?", "What is to be sustained?","How is sustainability measured?", "For how long will it be sustained?", What quantitative and qualitative standards must it meet?, and "At what geographic scale or biologic organizational level will it be sustained?", "What increments of improvement must be met and by what dates?, "What governmental and non-governmental entities have to cooperate to meet such goals?", and "What are the applicable legal requirements and prohibitions?"

INTRODUCTION

A diverse and constantly increasing set of methods and processes have been defined by Congress during the past century to balance the need to use natural resources against the need to protect the environment. This balancing has achieved a form of sustainability on the National Forests in the United States. There are approximately 224,966,052 acres of land within these National Forests. Additional lands are administered as part of the National Forest System as National Grasslands, Purchase Units, Land Utilization Projects, Research and Experimental Areas and other lands. The Executive and Judicial branches of government have played a major role in further defining and implementing these methods and processes. There has been a continued conflict between the viewpoints of those at one extreme who advocate unlimited use of renewable and non-renewable resources and the perspective of those at the other end of the spectrum who oppose any extractive use. Over the years, actual management has occupied various positions on this scale. The continuing Congressional balancing process takes place in a legal context bounded by the "Property Clause", the "Commerce Clause", the "Supremacy Clause", and the "Due Process" and "Takings" provisions of the Fifth Amendment to the United States Constitution.

For over a hundred years, there has been a parallel, but not necessarily equal rate and amount of, increase in human population, industrialization, information, laws, regulations and court decisions.

"Sustained yield"of renewable resources, as that term is used in the Multiple Use-Sustained Yield Act of 1960 and the National Forest Management Act of 1976 is viewed by some as being commodity oriented. On the other hand, one Federal District Court has quoted with approval a statement from an law review article that the National Forest Management Act "requires the Forest Service to treat the wildlife resource as a controlling, co-equal factor in forest management and, in particular, as a substantive limitation on timber production". Seattle Audubon Society v. Moseley 798 F.Supp. 1484,1489 (W.D.Wash. 1992). The debate continues and "sustained yield" must be read together with other statutory language which in the aggregate allows considerable flexibility and discretion to the land managing agency in applying an ecological approach to the multiple-use management of the National Forests and Grasslands. While "sustained yield" and "sustainability" are not synonymous, there is considerable overlap of the meaning of the two terms.

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"Sustainability"

As issues arise, a federal land manager is concerned about what is (a) legally required, (b) legally prohibited, and (c)legally authorized within the manager's discretion. The area between what is prohibited and what is required can be viewed as the manager's discretionary "decision space". As proposals or arguments containing particular terms are presented to a manager, he or she has to identify those terms and determine (a) the definition and (b) the context that apply. The manager is typically not a lawyer and may have limited access to legal advice.

Some definitions appear in statutes, others in technical or scientific literature, and still more in common usage. The terms may have with very different meanings in each of these contexts and with different people.

The terms "sustainable" and "sustainability" are being presented frequently in issues regarding the management of the National Forests in the United States. These terms are interpreted differently in different contexts.

A similar sounding term, "sustained yield", appears in the statutory context applicable to National Forest System lands (16 U.S.C. Sec. 1609), in association with the term "multiple use". 16 U.S.C. Sec. 528 and 1600. It is defined in 16 U.S.C. Sec. 531. With respect to the lands managed by the Bureau of Land Management in the Department of the Interior, "multiple use" and "sustained yield" are defined in the Federal Land Policy and Management Act of 1976 ("FLPMA"). 43 U.S.C. Sec. 1703. The definition of "multiple use" has broader scope in FLPMA.

From a grammatical perspective, "sustainable" is frequently used as an adjective and is strongly influenced by the terms that it modifies, e.g. "sustainable economics", "sustainable agriculture", "sustainable biodiversity", etc. A particular adjective-noun pair can have a very broad scope and include more than one of the other pairs, e.g. "sustainable society".

A "sustainable society" is discussed in Meadows, et.al. Beyond the Limits p. 209 (1992). The authors suggest that such a society must deal with material and energy to meet the following conditions:

1. Its rates of use of renewable resources do not exceed their rates of regeneration,

2. Its rates of use of non-renewable resources do not exceed the rate at which sustainable renewable substitutes are developed.

3. Its rates of pollution emission do not exceed the assimilative capacity of the environment.

The word "sustainability" has a similarly broad scope. Since there is no generally accepted definition of these terms, any discussion should include a definition of terms.

In the context of the management of the National Forest System Lands in the United States, the terms "diversity" (16 U.S.C. Sec. 1604(g)(B)), "viable populations" (36 C.F.R. Sec. 219.19 and 219.27(a)(6)(1992)[a term not defined or used in current statutory law] and "diversity" (16 U.S.C. Sec. 1604(g))(3)B)), 36 C.F.R. Sec. 219.3, 219.26 and 219.27 (a)(5) and (g)(1992) are currently in frequent use. Their relationship to the terms "sustainability" and to the complex fabric of statutes and regulations which control the occupancy and use of National Forest System lands is the subject of current debate. With respect to the wildlife resource, see Seattle Audubon Society v. Moseley 798 F.Supp. 1473 (W.D. Wash. 1992). We can expect that, as the public continues to call attention to these terms and their application, the three branches of the federal government will continue the evolutionary change in the legal principles that control the management of federal lands.

Human Actions Affecting Sustainability

Fire, erosion, vulcanism, temperature and other natural processes affect resources. In addition to natural processes, it can be argued that there are very few acres in the world which have not been affected to some extent by air quality or other effects traceable to human activity. For this, and other demographic, economic and political reasons, it does not seem to be realistic, at the present time, to equate "sustaining" natural resources with total preservation from human effects.

This paper, however, focuses on human actions that affect National Forest System lands. The resources listed in the Multiple Use-Sustained Yield Act of 1960, i.e. outdoor recreation, range, timber, watershed, and wildlife and fish, can have significant environmental effects. 16 U.S.C. Sec. 528. In addition, mineral related activities can have significant effects. Mineral activities are not considered to be "renewable resources' and were not included in the Multiple Use-Sustained Yield Act of 1960 because "lands more valuable for mineral.." were excluded from the National Forests. 16 U.S.C. Sec. 475 and 478. This can be contrasted with the definition of "multiple use" which is applied to lands administered by the Bureau of Land Management. 43 U.S.C. Sec. 1702. The effects of mining activities are evaluated in the course of considering proposed operating plans. 36 CFR Sec. 228.1 et.seq. Surface impacts of oil and gas activities are considered in the course of the various stages of oil and gas leasing. 36 CFR Sec. 228.100 et.seq.

Construction of and use of rights of way for roads, ditches, canals, dams and reservoirs also produce environmental effects. See, Section 501 et.seq. of the Federal Land Policy and Management Act ("FLPMA"), Public Law 94-579, and the list of earlier right of way statutes which were repealed by Secs. 702-706 of FLPMA. FLPMA also

contains significant provisions relating to grazing on public lands and National Forest System lands. 43 U.S.C. Sec. 1751, et. seq. The impact of grazing on those species and runs of Salmon protected under the Endangered Species Act is a current issue in the northwestern states.

While more attention is generally given to the effects of affirmative human actions, the absence of human intervention, for example in the area of fire suppression can result in an increase in sedimentation and at least a temporary decrease in water quality and in air quality. The absence of actions to control disease and insect damage to the Forests can also produce environmental effects.

The technical term "biodiversity" may be considered to be a component of many interpretations of "sustainability". It also can be considered as a component of "sustainable ecosystems". Accordingly, effects on biodiversity are generally effects on sustainability. In its January, 1993 publication entitled "Incorporating Biodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act" the Council on Environmental Quality defines the term as "the variety of life and its processes". See also, the April, 1991 Report of a Keystone Policy Dialog, "Biological Diversity on Federal Lands" and the Council on Environmental Quality's January, 1993 report entitled "Incorporating Biodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act.".

The 21st Annual Report of the Council on Environmental Quality at pages 151-153 (1991) in a technical, rather than legal, context listed certain human causes of loss of biodiversity:

1. Physical alteration of the environment both on land and in coastal and near shore areas;
   a. conversion to other land uses
   b. partial conversion
      (1) fragmentation—in general, the division of an ecosystem into isolated patches, thereby creating barriers to dispersal and population mixing of some species. Fragmentation, also exposes the interior of the remaining patches to the external physical and biological factors called "edge effects".
      (2) simplification—i.e. loss of diversity.

2. Chemical stress, including acid deposition and excess of ozone, nutrients, and pesticides;

3. Direct taking, such as large incidental fish bycatches during commercial seafood harvesting;

4. Introduction of exotic species that invade natural communities and displace native species; and

5. Plastics in the aquatic environment that trap or are ingested by fish, birds, and mammals.

These general principles may, or may not, all apply in a given factual situation.

NATIONAL FOREST SYSTEM LANDS

General Context

The total land area of the United States is approximately 3, 536,342 sq.mi. (2,263,258,800 acres). Statistical Abstract of the United States 1991 p. 201. In general, this area consists of (1) the original thirteen states, (2) the land ceded by Spain in 1819, (3) the land acquired in the Louisiana Purchase in 1803, (4) the Texas annexation in 1845, (5) the Oregon Territory (1846), (6) the land ceded by Mexico in 1848, and (7) the land purchased from Russia in 1867.

A variety of laws encouraged the settlement of what is now the western United States. The Homestead Act of 1862, which has since been repealed by the Federal Land Policy and Management Act of 1976, was codified in 43 U.S.C. Sec. 161, 162 and 173. It provided for the acquisition of up to 160 acres of non-mineral public land for agricultural purposes.

At the time of the "gold rush" in 1848, there was no federal mining law. Miners were, in effect, trespassers on the public domain. The Lode Law of 1866, Ch.262, Sec. 9, 14 Stat. 251, 253 attempted to remedy this situation. It provided a system based on the rules and customs in the mining districts. The Lode law was replaced by the General Mining Law of 1872, Ch. 152, 17 Stat. 91, which among other things imposed the requirement that the minerals on a mining claim be valuable. In later years, an increasing number of specific materials were exempted from this very lenient legislation and put under a more stringent leasing process, e.g. the Mineral Leasing Act of 1920, 30 U.S.C. Sec. 181 et.seq. The presence of private property rights, such as patented homesteads or mining claims, within a National Forest affects the discretion of the land managers. One of the tools which has been developed to protect particular areas from mineral development is the withdrawal of lands from mineral entry. See, 43 C.F.R. Subpart 2310 and 43 U.S.C. Sec. 1714, et.seq.

These laws provide examples of processes by which private parties acquire ownership of or vested rights in federal lands. The quantity and distribution of private interests within the National Forests has a practical effect on the amount of discretion that the federal land manager has regarding the surrounding federal lands. Questions continually arise regarding the authority of the federal land

manager to protect the federal lands from residual waste materials, actions proposed or activities taking place on private lands.

Beginning in the latter part of the 19th century, laws were enacted and Presidential Proclamations were issued to reserve lands from the public domain and protect them. The first federal Forest Reserve, the Yellowstone Timberland Reserve, and the first National Park, Yellowstone, were both created in 1872, the same year as the enactment of the General Mining law. As time went on, more special areas were designated, e.g. additional national parks, national monuments, wildlife refuges, etc. Wilderness areas also have been designated by Congress to preserve and protect those values.

These efforts to regulate specific activities or to protect specific lands or values are approaches that Congress has used to protect various aspects of what we now know as the "sustainability" of resources. The concern is not new. Some terminology is new. The global intensity of concern seems to be at an all-time high.

Land Management Legislation for the National Forests

The power to manage and control the National Forest System Lands in the United States is vested in Congress by Article IV, Section 3 of the United States Constitution, popularly referred to as the "Property Clause". This clause reads,in part:

The Congress shall have Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States....

This delegation of power is essentially unlimited. Gibson v. Choteau *80 U.S.(13 Wall.) 92, 99 (1872) and* Kleppe v. New Mexico *426 U.S. 529 (1976). By a series of statutes, some of which are discussed below, relating to the National Forests, Congress has, in turn, delegated broad discretion to the Secretary of Agriculture. As a general rule, which has some exceptions, the authority which the Forest Service has under "Property Clause" statutes stops at the National Forest boundary. As more attention is being given to areas defined on the basis of natural characteristics, rather than political or administrative boundaries, e.g. watersheds or landscapes, it becomes apparent that a great deal of cooperation will be needed from state and local governments, Indian tribes, and private landowners if land management principles related to sustainability are to be implemented throughout a watershed or landscape.*

Creative Act of 1891

The public domain lands were available for homesteading and other acquisitions. The Forest Reserves and later, the National Forests, were created to regulate occupancy and use. A few statutes can be selected to illustrate the evolving specificity of Congressional direction for the management of the National Forests. The first such statute is Section 24 of the Act of March 3, 1891, 26 Stat. 1095. It reads in part,

That the President of the United States may, from time to time, set apart and reserve, in any State or Territory having public land bearing forests, in any part of the public lands wholly or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations, and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof.

This statute, as amended, is currently codified in 16 U.S.C. Sec. 471. The problem which this statute was enacted to solve is described on page 3 of Senate Ex.Doc. No. 36, 51st Congress, 1st Session (Serial No. 2682) as "Timber thieving and destruction by fire". The primary concern was the increased water run-off which results from the removal of forest cover. Today, the issues raised in public involvement, administrative appeals, and litigation concerning Forest Service timber sale decisions raise a variety of issues, e.g. anticipated effects on wildlife, fish, water quality, and aesthetics. The Senate Executive Document referred to above is a transmittal dated January 20, 1890 by President Benjamin Harrison to the Senate and House of Representatives of a report of the American Association for the Advancement of Science. The Association stated in the report that:

Twelve years have passed, during which sufficient knowledge of our forest conditions and of the general relations of these to cultural, climatic, and economic conditions has been gathered, to show that further action on the part of the General Government is necessary if we wish to preserve the relation favorable to the future development of the country.

The report also contained a resolution adopted by the Association which reads, in part:

Resolved, That it is the sense of the American Association for the Advancement of Science that immediate action should be taken looking to the establishment of a proper administration of the remaining timber lands in the hands of the Governments of the United States and Canada, for the purpose of insuring the perpetuity of the forest cover on the western mountain ranges, preserving thereby the dependent favorable hydrologic conditions. 28, 1891 during the Second Session of the 51st Congress. (22 Cong.Rec. 3545 et.seq.)

While the concern here was settlement of public lands in the western United States, irrigated farming, and other aspects of stream-flow, the proposed solution was legislation to protect the government-owned timber lands. The term "perpetuity" establishes close ties to the more all-inclusive modern term "sustainability".

Organic Act of 1897

The 1891 Act was not sufficiently successful in dealing with the problem of protecting timbered lands. This frustration resulted in the Act of June 4, 1897, 30 Stat. 35 and 35 which provided, in part, that the Secretary:

> *...may make such rules and regulations and establish such service as will insure the objects of such reservations, namely to regulate their occupancy and use and to preserve the forests thereon from destruction.... 16 U.S.C. Sec. 551.*

The "preserve the forests thereon" language seems to be well within the scope of the more recent umbrella term "sustainability". The "objects of such reservations" refers to the purposes for the National Forests as stated in the 1891 Act (16 U.S.C. Sec. 475) which reads, in part:

> *...No national forest shall be established, except to improve and protect the forest within the boundaries, or for the purpose for securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States....*

The term "continuous" seems to be related to "perpetuity". The "use and necessities of citizens of the United States" brought the human element within the delegation to manage National Forests a century ago.

Multiple Use-Sustained Yield Act of 1960 ("MUSYA")

While much legislation was enacted relating to federally owned land between 1897 and 1960, in an over-view such as this it seems appropriate to shift the focus now to the Act of June 12, 1960, 74 Stat. 215, which is commonly known as the "Multiple Use-Sustained Yield Act of 1960". This legislation can be interpreted to accomplish the following:

1. It supplemented the purposes of the National Forests in the Act of June 4, 1897 (timber and watershed) to include outdoor recreation, range, wildlife and fish. 16 U.S.C. Sec. 528. These were listed as "resources", rather than "uses" 2 U.S. Code Cong. & Adm. News, 86th Cong., 2d Sess., p. 2379 (1960)

2. It specifically recognized the jurisdiction and responsibilities of the States with respect to wildlife and fish on the National Forests. 16 U.S.C. Sec. 528.

3. It reiterated the provision in the Act of June 4, 1897 that "lands more valuable for the mineral therein" were not included in the National Forests. Legislation relating to mining claims and mineral leasing authorized the use of these non-renewable resources.

4. It speaks of "multiple use and sustained yield of the several products and services obtained" from the renewable surface resources of the national forests. It is clear that these lands are to be used.

5. The definition of "Multiple Use" in 16 U.S.C. Sec. 531(a) speaks of management of the renewable resources "over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions." This provides a legal basis for the management of the National Forests on a landscape scale.

6. The establishment and maintenance of wilderness areas was declared to be consistent with the Multiple Use-Sustained Yield Act. 16 U.S.C. Sec. 529.

7. Specific provision was made in 16 U.S.C. Sec. 531(a) that "some land will be used for less than all of the resources". The Multiple Use-Sustained Yield Act of 1960 is incorporated by reference in the National Forest Management Act of 1976, this provides a basis for the "zoning" or "prescriptions" in the Forest Plans to emphasize certain resources or uses on particular land and for the flexibility in applying requirements to a National Forest generally.

   For example, some lands may have a timber emphasis, others might emphasize grazing, still others might supply developed recreation site opportunities. This recognition of some lands being more suitable for some uses than for others is a basis for distinguishing plan level requirements from project level matters.

8. The Multiple Use-Sustained Yield Act specifically recognizes that decisions do not need to be made on the basis of the "greatest

dollar return or greatest unit output". 16 U.S.C. Sec. 531(a). This creates a legal environment where decisions can include a greater emphasis on non-monetary factors. In turn, this provides a basis for accommodating the concerns of those whose values emphasize aesthetic, cultural resource, wildlife, etc., which are difficult to express in monetary or other quantitative terms.

9. The "in perpetuity" provision in the definition of "Sustained Yield" ties in nicely with the general concept of "sustainability". The language in the same section regarding "without impairment of the productivity of the land" is also relevant to this concept. House Report No. 1551 from the 86th Congress, 2d Session on this legislation points out that in 1905, at the time that the administration of the national forests was transferred from Interior to Agriculture, the President directed that questions of policy regarding the management of these lands should be on the basis of "the greatest good of the greatest number in the long run". 2 U.S. Code Cong.& Adm. News, 86th Cong. 2d Sess. p. 2378(1960). This seems to be another allusion to "in perpetuity" or "sustainability". Gifford Pinchot, in his book "Breaking New Ground" describes the "Birth of the Conservation Movement" on pages 319 et.seq. in terms which are very similar to what we now refer to as "sustainability". At the same time, it is clear that Congress in 1960 was thinking primarily in terms of outputs of renewable resource "products and services" in a commodity sense.

National Forest Management Act of 1976 ("NFMA")

The Forest and Rangeland Renewable Resources Planning Act of 1974 (88 Stat. 476), as amended by the National Forest Management Act of 1976 (90 Stat. 2949), 16 U.S.C. Sec. 1600 et.seq. provides more detailed legislative direction for the management of the National Forests. The Congressional findings in 16 U.S.C. Sec. 1600 include:

1. the need for a comprehensive assessment of present and anticipated uses, demand for, and supply of renewable resources from the Nation's public and private forests and rangelands.
2. public participation in the development of the renewable resources program.
3. recognition that research will promote a sound technical and ecological base for effective management, use, and protection of the Nation's renewable resources.
4. confirmation of the principles in MUSYA.
5. recognition that a conservation posture is needed which will meet the requirements of our people in perpetuity.
6. recognition of the need for and value of recycling.

These concerns are spelled out in greater detail in the requirements for the Land and Resource Management Plans ("Forest Plans") in 16 U.S.C. Sec. 1604. In addition, the following are some specific requirements for the Forest Plans:

1. the plans must be prepared by a systematic interdisciplinary approach.
2. standards and guidelines are required
3. inventories shall be made and relied upon
4. the plans shall be amended and revised from time to time
5. the preparation of the plans shall be done in accordance with NEPA.
6. Forest Plans must provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives. 16 U.S.C. Sec. 1604(e) and (g)((3)(b).
7. harvest levels will be regulated.
8. generally,timber can be harvested only from suitable lands. 16 U.S.C. Sec. 1604(g)(3)(E). An exception is provided for salvage or sanitation harvesting or situations where there is imminent danger from insect or disease attack. 16 U.S.C. Sec. 1604(k).
9. clearcutting and other forms of even-aged harvesting are limited.

10. a committee of scientists provided technical and scientific advice on proposed scientific and technical advice.

11. projects must be consistent with the Forest Plans.

The Forest Plans provide a means to achieve a form of sustainability in a multiple use context.

Additional Historical Perspective

To keep terminology issues in perspective, it is important to remember that many of the lands which eventually became National Forests were used to produce a variety of commodities before and after the reservation for National Forest purposes took place. It is also relevant to consider that federal legislation reflecting a national concern for sustaining the renewable resources on the National Forests dates back over a century. The U.S. Forest Service itself recently celebrated the centennial of the 1891 Creative Act. As the population has increased and the cumulative effects of the uses made of National Forest System lands have increased, an ever-increasing number of statutes and regulations have been enacted to control such uses and their environmental effects.

Early in the Nation's history, Congress enacted laws which encouraged mining, agriculture, roads, ditches, canals, reservoirs, etc. with minimal regulation. The "pendulum" began swinging toward the regulation end of the scale as requirements became more stringent for receiving permission to use and for acquiring ownership of federal lands. These new laws were increasingly more detailed and specific. The cumulative effect of these laws at the present time has substantially reduced the discretion of the land managing agencies. These laws operated in a variety of ways. Some laws reserved federal lands for certain uses. Some minerals were placed under a leasing process rather than a "location" and "patent" process. Still later, specific values were protected, e.g. cultural resources (National Historic Preservation Act 16 U.S.C. Sec. 470 et.seq., Historic Sites Act of 1935 16 U.S.C. Sec. 461 et.seq., and the Antiquities Act of 1906, 16 U.S.C. Sec. 431 et.seq.), wilderness (16 U.S.C. Sec. 1131 et.seq.), wild and scenic rivers (16 U.S.C. Sec. 1451 et.seq.), bald and golden eagles 16 U.S.C. Sec. 668 et.seq.), threatened and endangered species (16 U.S.C. Sec. 1531 et.seq.), migratory birds (16 U.S.C. Sec. 703 et.seq.), clean air (42 U.S.C. Sec. 7401 et.seq.), water pollution prevention and control (33 U.S.C. Sec 1251 et.seq.), etc. Hazardous waste laws came into effect to provide still another level of protection (42 U.S.C. Sec. 6901 et.seq. and 9601 et.seq.) These laws can be regarded as legislative efforts to incrementally address the human causes of a loss of biodiversity and in turn a loss of sustainability.

While this legal history does resolve current issues, it does describe the constantly evolving fabric of measures intended to balance the need to use against the need to protect. It helps to define the context in which issues are addressed today. This history also shows the continuous "fine tuning" of the exercise of Legislative and Executive Branch discretion. Well into the current century, the emphasis was on the development of agriculture, range, timber and other resources on the public domain in the western United States. In the last half of the 19th century and the early part of the 20th, most public land laws determined when title to such federal lands could pass to a farmer, a miner, a ditch company, etc. While there was a concern for sustainable forests, detailed, specific environmental legislation as we know it today, did not exist. Such detailed legislation sometimes has the effect of reducing agency discretion and in other situations imposes limits on the use of resources.

Still other legislation provided a process for integrating all of these requirements and the relevant factual information for the federal decision-maker to make a sound and balanced decision. This may include the balancing and reconciliation of the need to use and the need to protect the resources.

INTEGRATING THE LAWS APPLICABLE TO THE MANAGEMENT OF NATIONAL FOREST SYSTEM LANDS

National Environmental Policy Act of 1970 ("NEPA")

Introduction

In the course of making a land management decision regarding specific National Forest System lands, the substantial number of laws discussed above must be read together and reconciled into a single set of legal requirements which are applicable to the specific lands at a particular point in time. This set of requirements is applied, with the benefit of public involvement information, through an interdisciplinary environmental analysis process to the resource and proposed action information utilizing available technical information and technology, particularly computer technology. The product is often a written decision document supported by an Environmental Assessment or

Environmental Impact Statement. The implementation of the decision should accomplish an appropriate authorized or required form of sustainability.

The primary statute which Congress has enacted to establish a process to integrate legal, factual, social, political, economic, technical and other information into sound, balanced decisions is the National Environmental Policy Act of 1969 ("NEPA"). 42 U.S.C. Sec. 4321 et.seq. and its implementing regulations in 40 C.F.R. Part 1500. The NEPA scoping process includes the identification of and working with affected federal, state, and local agencies and affected Indian tribes. 40 C.F.R. Sec. 1501.7(a)(1), (4) and (6). Particular emphasis is placed upon the Endangered Species Act and working with the Fish and Wildlife Service. 40 C.F.R. Sec. 1502.25. See also, 50 C.F.R. Sec. 402.06 and 16 U.S.C. Sec. 1602.

NEPA is a pre-decisional process

In the course of preparing an environmental impact statement or other "NEPA" document, compliance with laws, regulations, and Executive Orders relating to air quality, water quality, hazardous waste, floodplains, wetlands, etc. will take place at the same time, prior to a decision on the proposed action.

Compliance with NEPA and the Endangered Species Act must be completed before the decision is made on the proposed action. 40 C.F.R. Sec. 1506.1 and 1506.10 and 50 C.F.R. Sec. 402.09.

Forest Planning

The NEPA process must be integrated into early planning, which would seem to include activities under the National Forest Management Act. 40 C.F.R. Sec. 1500.5(a), 1501.2(b), 1502.4(b), 1501.1(a) and 1508.18(b)(2).

Sustainability

The Congressional statement of purpose in NEPA includes a national policy "which will encourage productive and enjoyable harmony between man and his environment". 42 U.S.C. Sec. 4321. NEPA also provides a basis for broad scope analysis and discussion of ecosystem management.

One of the purposes of NEPA is to "enrich the understanding of the ecological systems". 42 U.S.C. Sec. 4321. This ties in with the "interdisciplinary" requirements contained in the regulations implementing NEPA. 40 C.F.R. Sec. 1501.2 and 1502.6 and the similar provisions in 16 U.S.C. Sec. 1604(b).

The concept of "sustainability" seems to be included within the statement of the continuing responsibility of the Government to "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations". 42 U.S.C. Sec. 4331(b)(1).

While the terms "sustainable" or "biodiversity" are absent from this legislation, all are relevant to these conservation concepts. See, Gifford Pinchot, "Breaking New Ground". The extent to which the Forest Service is currently implementing the concept of sustainability is the result of the interaction of all of these legal requirements.

The National Forest Management Act provides that "...the Forest Service ...has both a responsibility and an opportunity to be a leader in assuring that the Nation maintains a natural resource conservation posture that will meet the requirements of our people in perpetuity..." 16 U.S.C. Sec. 1600(6). Other statutory language which relevant to the issue of sustainability is discussed above in the section entitled "National Forest Management Act of 1976 ("NFMA").

Global Scale of Concern

The scale of interest is no longer just local. Environmental law is now evolving on a global and international scale. 16 U.S.C. Sec. 1601(a)(1), 42 U.S.C. Sec. 4332(F), and 16 U.S.C. Sec. 1537.

In June of 1992, an "Earth Summit" was held in Rio de Janeiro under the official designation of "United Nations Conference on Environment and Development (UNCED). Among the products of this gathering were: (1) a "United Nations Framework Convention on Climate Change", (2) a convention on "Biological Diversity", and (3) a " Rio Declaration on Environment and Development" and a "Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation, and Sustainable Development of All Types of Forests." The United States did not sign the Biological Diversity convention.

Jurisdiction

In Forest Service decision-making, the initial determination of whether a federal or state law applies to the National Forest System lands in question is often made at an administrative level during a NEPA process. These initial administrative determinations affect the resulting composite set of legal requirements for the proposed action, including those provisions that affect sustainability. In order for the law to apply, the legislature or other entity adopting the requirement has to have jurisdiction over the land, subject matter or persons involved.

Congress may enact laws which give one federal agency shared or primary jurisdiction over some aspect of lands managed by another agency.

Sometimes, contracts or land use authorizations must be taken into account and the terms of such documents may control the outcome on a particular issue.

A definition or legal requirement may or may not apply to particular types of land, e.g. national parks, national monuments, wilderness, wild and scenic rivers, wetlands, floodplains, critical habitat determined under the Endangered Species Act.

Substantive Requirements v. Procedural Requirements

The obligation under NEPA to study and disclose crosses political and organizational boundaries. However, NEPA is simply a process statute. Robertson v. Methow Valley Citizens Council 490 U.S. 332, 350 (1989). NEPA is based on the general power, limited by the Separation of Powers doctrine, of Congress to legislate for the other two branches of government. Authority to impose mitigation measures or to compel action by non-federal parties or to set biodiversity goals on a landscape level must come from other, substantive, legislation. The authority provided by the Organic Act, National Forest Management Act and Federal Land Policy and Management Act is based upon the Property Clause of the U.S. Constitution and would generally stop at the National Forest boundary. Other legislation, for example the Clean Air Act, the Clean Water Act and the Endangered Species Act are based on the Commerce Clause and are generally independent of land ownership. The Commerce Clause is found in Article 1, Sec. 8, Cl. 3 of the United States Constitution. It reads "... to regulate Commerce with foreign Nations, and among the several states, and with the Indian tribes....". Using this rationale, an issue raised during a NEPA scoping process might well be an issue regarding effects of the proposed action and would be discussed in the NEPA documents. However, unless there was a substantive statute regarding biodiversity, there might be a lack of authority to impose particular mitigation measures.

Hierarchy of Legal Requirements

Within the federal system, there is a hierarchy of legal materials: Constitution, statute, and regulation. The branches of government, legislative, judicial and executive are in a "separation of powers" or "checks and balances" relationship. Each branch of government has some areas where it will prevail over another branch.

At the state level there is a similar hierarchy. In case of conflict, a regulation yields to a statute, a statute yields to the Constitution. State level provisions yield to federal provisions if preemption criteria are satisfied under the Supremacy Clause of the United States Constitution.

The Supremacy Clause is found in Article VI, Cl. 2 of the United States Constitution. It provides that "This Constitution, and the Laws of the United States which shall be made in Pursuance thereof; and all Treaties made, or which shall be made, under the Authority of the United States, shall be the supreme Law of the Land; and the Judges in every State shall be bound thereby...." In general, state environmental laws apply to federal land; however, state land use laws do not. The U.S. Supreme Court has formulated criteria over the years to distinguish between state and county regulations which violate the Supremacy clause from those which do not. In general, those criteria are: (1) Does the federal law occupy [the subject matter] field?, (2) Is there a between the federal provision and the state provision such that either (a) a person cannot comply with both or (b) the state or county provisions stand as an obstacle to the accomplishment and execution of the full purposes and objectives of Congress? If a state law or local government ordinance deals with both the "police power" areas of health, safety, and welfare and land use control, the question is what impact does the non-federal provision have on the implementation of the Congressional policy or interferes with the method by which the federal statute was designed to reach a particular goal. Gade v. National Solid Wastes Management Association 120 LEd2d 73 (1992).

As state and local governments become increasingly interested in the management of federal lands, issues are being raised as to whether particular state environmental and land use requirements apply to activities on federal lands and to the holders of federal leases, permits. This makes the job of the manager even more challenging as sustainability and other issues are addressed on the federal lands.

Potential limits on agency action: "Regulatory Takings" under the 5th Amendment

When an agency acts in a manner which affects persons or property, the Constitution imposes certain limits. The procedural component of the Due Process clause of the Fifth Amendment includes a general right to notice and an opportunity to be heard if Constitutionally recognized personal or property rights are to be affected. Substantive due process includes a requirement of legal sufficiency and clarity of a requirement that is to be enforced. If Constitutionally protected property rights are to be affected, they cannot be so severely affected as to constitute a "taking", unless there is just compensation. The United States Supreme Court has developed general criteria to distinguish between governmental action which effects a

taking of private property and an action which does not. Those criteria are (a) Is there an economically viable interest left in a Constitutionally protected property right?, (b) Has there been an unreasonable interference with a reasonable investment backed expectation?, and (c) Was the governmental action taken to implement a valid governmental purpose? Nollan v. California Coastal Commission 97 LEd2d 677(1987), Lucas v. South Carolina Coastal Council 120 LEd2d 798 (1992), and First English Evangelical Lutheran Church of Glendale v. County of Los Angeles 482 U.S. 304 (1987). As land managing agencies take actions, perhaps to improve sustainability of the resources involved, holders of private rights and privileges affected may suggest that they are being subjected to a regulatory taking.

CONCLUSION

Since "sustained" modifies "yield" and is associated with "multiple use", it will generally overlap to some extent, but will not be synonymous with, most uses of the term "sustainability". Because of this overlap in meaning, it would be inappropriate in most cases to argue that "sustainability is being ignored" or that "sustainability is a whole new ball game". A form of "sustainability" is rooted early in the federal laws relating to federal lands. This concept has evolved over the years and there is no reason to believe that the evolutionary process has been completed. It is also important not to consider "sustainability" as a concept independent of "sustained yield". As a practical matter, sustained yield is included within "sustainability". In other words, "sustained yield" is a minimum, not a maximum. Congressional interest in a form of sustainability has been with us for over a century and a great deal has been done legislatively and administratively to balance the need to use against the need to protect the environment. The issue is normally whether agency discretion should be used in a particular case to either authorize a use or deny it. On a broader scale, the issue at the legislative or Departmental level is whether the "pendulum" of regulations and policies directly or indirectly affecting commodity uses of federal lands should swing more toward lenient regulation and greater commodity use or toward more stringent regulation and a greater emphasis on sustainability in the immediate future. The Constitution and statutes generally allow flexibility for some adjustment without the need for new legislation.

Recently, the Forest Service has more clearly defined its mission to use an ecological approach to the multiple-use management of the National Forests and Grasslands. In other words, more attention is being given to integrating and reconciling considerations of sustainability and ecosystem processes with considerations of resource use, commodity production, and development of federal lands.

The events and concepts summarized above show a gradual evolution of the requirements and prohibitions which define the decision space for managing one category of federal property in the United States. This evolution is paralleled by the increase in population and demand for resources. During this period of approximately a century, the fund of knowledge about the federal lands has also increased. All of these factors, including the legal requirements which shape the form of sustainability implemented on federal lands can be expected to continue to evolve.

Community Land Grants and the Forest Service as Watershed Managers: The Example of Santo Domingo De Cundiyo

G. Emlen Hall[1]

Abstract — Spanish and Mexican land grants in the southwest were designed to govern watersheds. The wood, the water and the forage of the upland ejidos were as critical to community survival as the house lots and irrigated lands that lay at the bottom of the watersheds. The example of the Santo Domingo de Cundiyo Grant in New Mexico shows that United States succession to sovereignty over New Mexico in 1848 resulted in division of authority over watersheds between the land grants and the Forest Service. Conflicting laws and interests now govern watersheds to the detriment of both the Forest Service and land grant heirs. Better management and diminished conflict would result from a sharing of power over single watersheds.

INTRODUCTION

In the centuries before the United States succeeded to sovereignty over the southwestern United States in 1848, Spanish and Mexican government officials used land grants to permit and control management of natural resources. Those officials used the community land grant mechanism to define areas of resource access and control. Often the boundaries of these community lands grants were coterminous with natural watersheds so that land grant communities managed integrated ecological units for the sustenance of the communities that lay at their heart.[1]

In effect, Spanish and Mexican officials depended on land grant communities to sustain themselves in perpetuity by using wisely the resources within the watershed boundaries. With the exception of minerals, which were reserved to the national sovereignty for special dispensation under Spanish and Mexican law, community land grants controlled the other basic watershed resources—the water, the grass, the timber, and the access to them that made their use possible—necessary to the support of the intricate subsistence economies of the local communities.[2] Based part on intensive irrigated agriculture and part on more diffuse livestock grazing in the uplands, these subsistence economies drew on all the watershed resources.[3] Like the Forest Service, New Mexico land grants were multiple-use, sustained-yield agencies from the beginning. "Non-declining even flow" is not a term that Hispanic land grant residents would have recognized but its principals were embodied in the concept of "verguenza" which counselled the wise use of scarce resources for this generation and the next.[4]

In the years after United States succession to sovereignty in 1848, much that had allowed for unified land grant watershed management changed. In the later half of the nineteenth century, the United States adjudicated the nature and extent of community land grant claims to land and resources. In some instances, the United States courts denied the validity of alleged New Mexico land grants altogether. In others, the United States officials charged with the confirmation of grants arising under New Mexico's antecedent sovereigns recognized Spanish and Mexican grants but greatly reduced their extent. Finally, in still other instances, the United States recognized grants to the full areal extent of their claims and, then, between 1920 and 1950, proceeded to purchase back parts of confirmed land grants, and to restore parts of the confirmed lands to public ownership.[5] Whether by rejection, reduction or re-purchase, the diminished size of New Mexico community land grants often left them without full control over the resources that the original watershed grants had conferred on them. After 100 years of United States rule, New Mexico land grants often discovered that at best they shared control over

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Figure 1. — This 1987 aerial photograph of the Sierra Mosca area shows the town of Cundiyo at the bottom, the confluence of the Rios Frijoles and Medio in the town, and the area between the two rivers in the uplands to the east. The uplands are now part of the Pecos Wilderness. The residents of Cundiyo considered those uplands their ejido.

watersheds with the United States government, usually in the form of the Forest Service. This fracturing of political and legal control over ecologically integrated watersheds led to inevitable tension as the preference for one resource over another by one of the watershed controllers inevitably impacted on the potentially different resource choices of the other watershed controller.[6]

The land grant preferences were, of course, primarily affected by the subsistence and survival demands of the small communities at their heart. The government's preferences were primarily affected by national laws, by agency regulation and by national and regional policy. The laws varied from resource to resource, from regulation to regulation, and from region to region. However, despite the complex overlays of federal public land law, there remains a common denominator to the constant tension between land grants and the Forest Service: split authority over the resource governance of a single watershed, with each authority operating under different legal regimes and serving different interests.

CUNDIYO: WHERE CONSEQUENCES COLLECT

The Santo Domingo de Cundiyo community land grant, less than an hour's drive north of Santa Fe, illustrates both how this split came about and what resource problems it has produced. The small town of Cundiyo sits just above the confluence of the Rio Medio on the north and the Rio Frijoles on the south. The heart of the town is formed by three small, relatively open irrigated tracts of less than 100 acres all together, on both sides of both rivers just after they debouch for the first time from the nine miles of mountainous country above them and just before they join to form the Rio Santa Cruz and drop further down to Chimayo.[7]

This relatively small, intensely cultivated, densely settled pocket at the base of the much larger areas that these two rivers drain is where the local community lives and farms. The relatively much larger, unsettled, mountain uplands between the two rivers was nevertheless critical to

the Cundiyo heartland in at least two senses. First, the uplands themselves provided critical resources—water, timber, summer grass— indispensable to local life.[8] Second, the downstream heartlands were directly influenced by the upstream land uses. The irrigated fields and residences of Cundiyo collected the consequences of the resource choices that were made upstream. The reasons that Cundiyosos must now yield to the Forest Service in determining what upland resources they may now access and what upland consequences they must suffer lie in the history of the land grant under three sovereigns.

The government of Spain made the Santo Domingo de Cundiyo grant in 1743.[9] Two aspects of that ancient history have special current importance. First, the boundaries of the grant, especially on the north, towards the Truchas Grant, and on the east, towards the Sangre de Cristo cordillera, were vague. Nevertheless, the Cundiyo community had no doubt where those boundaries lay. Cundiyosos understood that to the north the grant boundaries extended to the Truchas Grant and thus included both the Rio Frijoles and the Rio Medio. Cundiyosos also understood that to the east the grant boundaries extended to the Sierra Mosca and thus included the headwaters of both creeks. In other words, Cundiyosos understood that their grant included the contiguous watersheds of the two creeks from the headwaters to the confluence where residents lived and farmed.[10]

That, however, is not the way the Cundiyo Grant turned out. When the grant was finally submitted for confirmation before the appropriate United States tribunal, no one raised any questions about the grant's underlying validity. Nevertheless, the boundaries of the grant caused problems. Caught before the late 19th century Court of Private Land claims somewhere between government reluctance to give up too much pubic domain and lackadaisical grant representation, the Cundiyo grant was found to include only the heavily settled, intensively cultivated bottom lands of the grant and then at that only those irrigated from the Rio Frijoles, not the Rio En Medio. In losing its ownership claim to the balance, Cundiyo also found that it had lost its claim to resource control. In effect the grant had won the confirmation battle only to lose the watershed war. From then on the balance of the watershed belonged to the national public domain.[11]

Over the same long period of time, Cundiyo struggled to define the nature of its ownership in the land and resources that had been confirmed to it. Under existing Spanish law, in effect in 1743 when the grant was made, Cundiyo was a private grant. That designation meant that it belonged not to any corporate political community but to the three original individual grantees and their heirs. That tendency toward privatization, begun under Spanish law, accelerated under Mexican rule. By the mid-1830s, the families of the three original owners of the grant had conveyed their private interests to a distant relative, Jose Antonio Vigil. What had begun as the private property of three individuals in 1743 had become by 1848 the private property of one man.[12]

The process of privatization that characterized the first hundred years of the Santo Domingo de Cundiyo Grant reversed itself in the second hundred years. Between 1848 and 1948, the children and further descendants of Jose Antonio Vigil stayed on the grant that their ancestor had purchased, established their homes and farms there, and became through the generations the kind of isolated, tightly-knit Hispanic group that characterized New Mexican towns everywhere.

In 1976 there were twenty-nine occupied residences in Cundiyo. Vigils lived in twenty six of the dwellings, all direct lineal descendants of Jose Antonio Vigil. Trujillos lived in two of the other houses; they were directly related to Jose Antonio Vigil by marriage. Only one occupied Cundiyo residence belonged to a non-Vigil. In the last twenty years a few additional non-Vigils have arrived, but essentially the Santo Domingo de Cundiyo Grant still belongs to the extended family of Jose Antonio Vigil.[13]

Beginning in the 1920s this extended Vigil family began to operate the Cundiyo grant as if it were a community grant. Without any higher authority, family members formed an elected board. The Board exercised the powers conferred by state statute on formal community grants. The Board paid real property taxes and regulated the use and enjoyment of its small remaining common lands left after the United States had so reduced the grant in confirming it. In general the Santo Domingo de Cundiyo Land Grant Board behaved like a community grant even though it technically was not one.[14]

In two especially noteworthy ways the Board demonstrated a particularly wise stewardship of the resources left to it. First, it recognized the limited critical resources left to it after the United States confirmation and sharply curtailed their use. By the 1930s the Land Grant Board had forbidden the public and grant residents alike to cut live timber on the grant's remaining lands. There was insufficient timber there for all grant residents forever so the Board denied what little was left to all.

More importantly, the Board limited formal membership in the grant. By 1976 there were perhaps 500 living heirs of the original Jose Antonio Vigil. By the technical laws of intestate succession each of these heirs had an equal, undivided interest in the remaining unapportioned ejidos of the grant. In other New Mexico grants this endless fracturing of property interests had either paralyzed the grants or, perhaps worse, made sale to outsiders the only viable management option. But at Cundiyo the Board moved early and firmly to prevent the endless multiplication of legal interests in the grant. By 1976 it had limited interests in the grant to 41 memberships and prohibited the further subdivision of those interests.[15]

By 1976 the Board of Directors of the Santo Domingo de Cundiyo Grant had defined itself and its grant. Even though it was a private grant it had re-made itself as a quasi-public, corporate land grant entity. And even though interests in the grant technically had multiplied cancerously, the Board had contained that murderous growth by limiting membership. The Board's crowning achievement came in 1977 when the Santa Fe County district court confirmed the nature of the Cundiyo Grant as a community grant and approved its management procedures.[16] Thus, even today, the Santo Domingo de Cundiyo Grant represents a well-organized, clearly-defined land grant organization in contrast to the chaos that characterizes large parts of the rest of New Mexico's land grant scene. The irony, however, is that the jurisdiction of this coherent organization has been so limited because the grant itself was so limited in the 19th century confirmation process. In that process, control of the watersheds was divided between the upland Forest Service and the bottom-land grant.

Now the story of the watershed lies in the tension between a clearly visible Grant and a clearly visible Forest Service and the sometimes quiet, sometimes noisier struggle over the particular resources of an integrated ecological area.

WATERSHED WATER

Cundiyo is still an agricultural community. Four community ditches—two each from the Rio Medio on the north and the Rio Frijoles on the south—serve approximately 100 irrigated acres on both sides of the rivers, bunched up at the very bottom of the watershed at its western edge. In addition to garden crops raised primarily for home consumption, these fields are planted to pasture and cut and bailed to provide for livestock over the winters.[17] Water rights in Cundiyo are defined by the state law of prior appropriation. They are old, with a priority of 1743. They have been perfected and maintained. However, these water rights derive from sources—the headwaters of the Rio Medio and Rio Frijoles—originating on what is now federal land.

Rights to water arising on upstream federal land derive from a separate, superior legal source than the rights of private irrigators downstream at Cundiyo. Federal water rights are different because they do not stem from appropriation. Federal water rights are superior because they are Federal. In theory, Forest Service reserved water rights could reduce, gallon for gallon, as the Supreme Court has said, the water that reaches the downstream Cundiyo diversions.[18]

In practice the possibility of new upstream federal diversions under a superior federal water right pose little threat to downstream Cundiyo supplies. The Forest Service's recognized reserved water rights are very small. Alternative basis for federal claims to water are not regarded seriously. And the wilderness status of most of the federal land guarantees that the United States is unlikely to make new, instrumental upstream uses of water. It is not as a new appropriator making new uses of water already committed to downstream irrigators in places like Cundiyo that the United States could effect the community land grant's use of water.[19]

Rather, it is as the manager of the watershed lands that the United States incidentally has effected the amount of surface water that reaches the downstream Cundiyo diversions. In Santa Fe and Taos Counties studies have found that vegetative practices on land managed by the upstream Forest Service has reduced by as much as 30% the basin yield of water to the streams. Even accounting for annual climatic variations, which are significant, Forest Service land use choices mean that there is less water in the streams.[20] Less water in the streams means, obviously, less water available at Cundiyo.

From the downstream perspective of Cundiyo water users, it does not make much difference whether the upstream United States is reducing downstream supplies by diverting water that already has reached the streams or by impeding water from reaching them in the first place. In either case, upstream choices dictate downstream water availability.

However, to talk of water intentionally taken from a common source is to speak in the idiom of water rights. On the other hand to talk of water incidentally prevented from reaching the stream in the first place is to talk the language of watershed management in general and vegetative management in particular.

In the special context of the Forest Service, "vegetative management" of the upland wilderness resources involves a critical upland resource—timber—and a critical aspect of its management—fire. In the hands of the Forest Service, the timber and fire policies fundamentally altered a basin landscape that itself had already been fundamentally altered prior to the imposition of forest service management.

WATERSHED TIMBER AND FIRE

Prior to the adjudication of the United States courts which so limited the uplands jurisdiction of the Santo Domingo de Cundiyo Grant, the heavily timbered mountain terrain above the village had been available for the subsistence timber needs of local communities. Before 1880 and the advent of the railroad in New Mexico, there was little demand on that resource. Cundiyo and neighboring Hispanic villages had neither the need nor the technical capacity to much exploit the timber above them.[21]

However, in the thirty years between the arrival of the railroads and the first inclusion of the Cundiyo uplands in the national forest system, new forces heavily exploited the most easily accessible timber there. The railroad brought a

heightened demand for local timber. The lingering, unadjudicated status of the Cundiyo land grant deprived the upland area of any sure control. The land grant could not control upland timber exploitation because it claim had not been confirmed. (It never was.) The United States did not control timber cutting because its ownership and jurisdiction had not yet been defined and extended. Private interests moved into the breach and removed a lot of valuable timber. By the time the United State's ownership of the uplands was confirmed and the jurisdiction of the Forest Service extended beginning in 1907, the timber landscape of the Cundiyo uplands had been fundamentally altered from what it had been prior to 1848.

Historical records show what the effect of this massive removal was just south of the Rios Frijoles and Medio, in the area of the Nambe-Pojoaque watershed. The water arrived downstream earlier in the year, arrived with greater sediment loads and did not continue as long through the irrigation season as a result of the upstream logging. Timbering's primary effect was not so much to affect a timber-dependent community as it was to change the water regime of a subsistence hydraulic society.[22]

Imposition of federal controls over the Cundiyo uplands in the 20th century changed all of that. Timber removal was sharply curtailed and then, with the full extension of the wilderness, prohibited altogether. In addition, fire containment policies, only very broadly mandated by law, regulation and broad administrative directives, called for control and suppression of natural (and man-caused) fires that themselves had played a significant role in determining the vegetative cover of the Cundiyo uplands and therefore their water yield. Forest service limitations on timber removal were aimed at restoring over-cut areas; forest service fire suppression guaranteed that the restored landscape would look different when it returned. Of course that new landscape would effect again and in new and different ways the amount of water that would reach downstream Cundiyo.[23]

At the least the imposition of Forest Service control had started the pendulum to swing back from the disastrous results of the early unregulated timber exploitation. However, Forest Service timber and vegetative regulation may have gone beyond the original purposes for which Congress authorized the establishment of national forests—"securing favorable conditions of water flows" in places just like Cundiyo, outside the boundaries of national forests but entirely dependent on water generated within those boundaries—and begun to adversely effect that end which the forest service was designed to protect.[24] In protecting timber and preventing fire, forest service managers may have saved the forest and hurt downstream water users. Cundiyosos suffer directly the tangled complication of these management ironies.

Some of this was straightened out beginning in 1988 when the Santa Fe National Forest instituted a new and controversial policy of prescribed and controlled burns for the Pecos Wilderness areas including the Cundiyo watershed.[25] The policy recognized that without fire the area could not restore itself to the desired wilderness condition where, in the language of the original Wilderness Act, the "earth and its community are untrammeled by man" and where "man himself is a visitor who does not remain."[26]

Such a fire policy would help restore to the downstream human community at Cundiyo the historical basin yield under pre-1848 conditions by eliminating the artificial, water-consuming basil load that had built up in the absence of fire. However, the human community would benefit only incidentally from a beneficial practice that explicitly directs that their human interests not play a role.

When it comes to timber, land grant communities are twice-removed from a land-use practice that profoundly affects their current lives. First, Cundiyosos have no direct in-put into timber management which directly affects their deeply-seated, long-established right to water. Secondly, Cundiyosos are marginalized as even interested parties under Forest Service wilderness policies which emphasize non-human values to the exclusion of human ones.

Of all the upland resources whose management and control by the Forest Service deeply affects the human community in Cundiyo, related timber, non-timber and fire practices are the ones from which Cundiyosos are most excluded. In contrast, Forest Service management of range resources in the Cundiyo uplands provides a model of participatory democracy.

RANGE RESOURCES

Since its founding in 1743 Cundiyo has sustained itself by a unique combination of intense irrigated agriculture on the small irrigable tracts near the confluence of the Rios Frijoles and Medio and much more widely dispersed livestock grazing over the rugged mountain terrain east of the village and west of the Sangre de Cristo cordillera between the two rivers. In the 19th century Cundiyosos grazed sheep over what they thought was the eastern 43,000 acres of their grant. In the 20th century they graze many fewer cattle over what is now the Sierra Mosca Allotment of the Forest Service within the Pecos Wilderness on land that belongs to the United States under permits issued and regulated by the Forest Service.[27]

The dramatic switch from sheep to cattle and from non-exclusive land grant land to United States public domain is related. The change in land ownership and control over livestock access was a direct function of the United States adjudication of the northern and eastern boundaries of the Santo Domingo de Cundiyo grant. The change in stocking patterns from sheep to cattle resulted partly from a

turn-of-the-century collapse in the wool markets and partly from the imposition of federal controls over grazing. Finding that the forest reserves east of Cundiyo were being overgrazed by sheep who caused special damage to range resources, the Forest Service restricted access for the first time and prohibited sheep. Cundiyosos reacted by switching to cattle as the livestock of choice and exercising the special place that early federal grazing policies left them in.[28]

In regulating the range, the Forest Service, like the precursors of the BLM, recognized that those grazers on the public domain who were dependent by use prior to the imposition of federal control and who had sufficient base property to maintain herds during those seasons when snow made the high country inaccessible would gain a preference in the issuance of federal grazing permits.[29] What Cundiyosos considered a right prior to the reduction of their grant boundaries and the imposition of federal grazing controls, now became a privilege. But the Cundiyosos' unique location and history placed them in an ideal position to exercise that privilege.

From the outset of federal regulation of grazing in the high country east of Cundiyo, members of the Vigil family, almost exclusively residing in Cundiyo, received the grazing permits that the Forest Service issued. The permits specified the stocking rate and season for each permittee in what became known as the Sierra Mosca allotment. For their part the Cundiyo holders of the permits banded together and formed the Cundiyo Livestock Association, a collection of Cundiyo permit holders operating under a detailed set of by-laws governing the common aspects of the communal grazing.[30]

What had been the board of directors of the Santo Domingo de Cundiyo grant, in charge of the multiple-use/sustained yield of all the resources within the original 50,000 acre grant had become the Cundiyo Livestock Association which had a much more modest role in the single use—grazing—of only one resource: range. What had been the common lands of the Santo Domingo land grant had become the Sierra Mosca grazing allotment.

That Livestock Association modest role was constrained in a variety of ways. For one, the United States and the Forest Service only had to consult with the Cundiyo Livestock Association. All the formal power resided in the Federal owners and administrators. In addition, all the technical decisions, the figuring of carrying capacity, the assessment of the state of the range, the rotation of grazing areas, belonged ultimately to the federal permitor, not the local permittees. Lastly, and perhaps most importantly, the ultimate mix of grazing in the multiple uses of the area became a matter of federal, not local, definition.[31]

Nevertheless, residents of the Cundiyo land grant maintained a direct voice in grazing affairs that they had lost when it came to the other resources of the uplands. Those other resources had been swallowed by other laws, as in the case of water rights, and other effects, as in the case of timber and fire. Only with respect to range resources had Cundiyosos maintained any measure of direct voice in the natural resources that most concerned them and their uplands.

The modern law of the range has confirmed that limited local voice. For grazing on National Forests the 1978 Public Range Improvement Act mandates allotment plans like the Sierra Mosca Allotment plan. The Act directs at least consultation with the permit holders within each allotment, like the Cundiyo land grant heirs, in the formulation of such allotment plans.[32] In this limited area, land grant heirs have improved. They now have a formal voice in the grazing process.

Still, the relative emphasis on grazing in any forest area is left primarily to the discretion of the federal Forest agency. In its Wilderness Acts, Congress has so far specifically directed that, at least with respect to the Pecos Wilderness, grazing permits should continue despite the Wilderness designation.[33] Otherwise, the Forest Service is free to strike its own balance between competing resource claims, thereby directly and indirectly influencing Cundiyosos' access to range.

Just across the Sangre de Cristo cordillera in the Cowles allotment of the Pecos District of the Santa Fe National Forest, Forest officials have transferred existing grazing permits to other locations, thus removing all cattle from the allotment.[34] Cundiyosos have not yet faced such an out and out ban. But at least one Cundiyo permittee fairly recently accepted a transfer of his grazing permit from the Sierra Mosca allotment, where he faced stocking reductions, to another allotment almost 80 miles away where the Forest Service guaranteed that he could run as many cattle as he historically had.[35]

Over the years, the number of animal units allotted to the members of the Cundiyo Livestock Association in the Sierra Mosca allotment consistently has declined. From a high of 200 head in the 1930s, the number of permitted animals in the Sierra Mosca allotment has dropped to 80.[36] This reduction may genuinely reflect either deteriorating or at least, non-improving, range conditions. But it may reflect as well a Forest Service determination that other incompatible resource uses—recreation and wilderness—are more important than the historic Cundiyo grazing uses. As the nearby cities grow, as tourism increases, as access to the Pecos wilderness becomes more desirable, pressure will increase to further reduce and finally eliminate grazing in the Sierra Mosca allotment just as the Forest Service has done in the Cowles allotment. Over that resource choice, Cundiyosos have no control.[37]

ACCESS

No problem so plagues current Federal land managers as the problem of access to public lands.[38] Cundiyosos have lost any direct control over the upstream resources to which

they once had access and now must suffer the downstream consequences of upland resource choices governed by laws they never made and processes to which they have minimum entry. Ironically in losing control over those resources, they have maintained some measure of control over other's access to them.

This is particularly true with respect to recreational users trying to reach areas within the Sierra Mosca allotment increasingly valuable for wilderness hiking, camping and fishing. From the west the easiest access to this uplands recreational paradise is along the traditional roads and trails that follow the Rio Frijoles on the south and the Borrego Mesa to the north. Of the two possibilities, the Rio Frijoles route is the most direct and, by chance, the one over which Cundiyosos exercise the most control.

When the United States adjudicated the boundaries of the Santo Domingo de Cundiyo grant, it left the bottom sections of the Rio En Medio out but put the bottom sections of the Rio Frijoles in. Above the southern irrigated fields of the Cundiyo grant, a narrow mountain canyon residents call the "Buningue" runs east along the Frijoles until it reaches the mountains themselves. A road runs through the grant, along the creek until it reaches the trailhead of the footpath that continues up along the creek through an even narrower canyon. The road provides principal access to the trail and the Pecos Wilderness beyond.

Over the years, traffic on the road and the trail grew as tourism increased and the Pecos Wilderness became a more popular destination. The land grant Board perceived the increased traffic as a threat to Cundiyo's peaceful enjoyment of the little that had been left to it. Unable to negotiate any restrictions on use with the Forest Service, Cundiyosos turned to local political institutions where they exercised more influence. In the mid-1980s Santa Fe County formally abandoned its rights to the road. The land grant Board placed a gate across the bottom of the road and locked it. Cundiyo had protected itself by making access to the public lands beyond much more difficult.[39]

Except as it falls into a general pattern of increasing problems with access to public lands over private lands, the incident of the Rio Frijoles road closure is not particularly important. But it illustrates nicely the tangled complications that Forest Service-land grant relations have become. As the upland recreational area becomes more valuable as a place where "man visits but does not stay", in the Wilderness Act's own phraseology, access became critical. On the other hand, as the consequences of the uplands resource choices collected at Cundiyo, those choices became more critical. Each side in the divided authority over the watershed was losing control over the resource factor most important to it.

CULTURE AND CUNDIYO IN THE PECOS WILDERNESS

Since 1972, if not before, the Southwest Region of the Forest Service has recognized that the ancient forest-dependent communities of the New Mexico mountain's--like Cundiyo--deserve a special place in local administration. The Forest Service expresses this preference in terms of "cultural" resources that are to be factored into the multiple-use balancing of conflicting resource claims that make up regional policy.[40] As with other factors that the Forest Service mixes and matches, the recognition of the "cultural" value of Hispanic land grant towns does little to say what weight will be attached to that value in the optimal mix of multiple uses.

Given the confused law that governs different resources, given the fact that Cundiyo has an historic interest in each of those resources, and, finally, given the fact that Cundiyo is affected more directly by up-stream, basin resource choices made by the Forest Service than other interested parties, then, perhaps, the cultural claim of the Cundiyo people to a say in basin resource management should be expressed politically. That is, the Forest Service should build into its basin resource choices a specific role for the Santo Domingo de Cundiyo grant.

The Forest Service already does this in consulting with the Cundiyo Livestock Association on range management in the Sierra Mosca allotment. It could expand this arrangement in two ways. It could broaden the range of inter-related resources on which the Forest Service consults with Cundiyo so that Cundiyosos have a special input with respect to timber, water and to access as well as to range. Secondly, the Forest Service could increase the power granted to the local community beyond the minimal "consultation" that is now required. In this way, the status of the land grant as an integral and historic part of the basin could be recognized and strengthened.

Local Forest Service district rangers sometimes already involve land grant communities in upland resource decisions. That informal practice should become formalized and institutionalized. Otherwise, wilderness management, based on the premise that man is a temporary visitor, will always offend land-based communities with a real historical claim to permanent use.

ENDNOTES

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5. See generally Ebright, "New Mexico Land Grants: The Legal Background" in Briggs and VanNess, eds. Land, Water and Culture: New Perspectives on Hispanic Land Grants UNM Press (Albuquerque, 1987); William deBuys, "Fractions of Justice: A Legal and Social History of the Las Trampas Land Grant, New Mexico" NMHR 56:71-97 (1981); Hall, "San Miguel del Bado and the Loss of the Common Lands of New Mexico Community Land Grants" NMHR 66:413-432 (1991).
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7. Bowden, Private Land Claims in the Southwest 6 Vols. (L.L.M, thesis, Southern Methodist University, V.3 p. 614. See Survey Plat attached to In Re Santo Domingo de Cundiyo Grant, No. 51054, Santa Fe County District Court.
8. VanNess, "Hispanic Land Grants: Ecology and Subsistence in the Uplands of Northern New Mexico and Southern Colorado" in Briggs and VanNess, eds. Land, Water and Culture: New Perspectives on Hispanic Land Grants (UNM Press: Albuquerque, 1987).
9. The grant documents are translated at Appendix B in White et. al. Land Title Study (Santa Fe: State Planning Office, 1971) ppg 219-220. Spanish Archives of New Mexico (SANM) I:1041 (State Records Center, Santa Fe) contains the original grant documents.
10. Jennifer Davis, "Perceptions of Power: The Court of Private Land Claims and the Shrinking of the Santo Domingo de Cundiyo Grant" UNM School of Law, February, 1984, ppgs 1-6.
11. Davis, "Perceptions of Power" 7-24; Adjudication of the Cundiyo Grant before the Court of Private Land Claims in NMLG-PLC, Reel 52, Case 211, State Records Center and Archives, Santa Fe.
12. Davis, "Perceptions of Power", 5-6; Theresa Johnson, "Jose Antonio Vigil and Cundiyo" UNM Law School, 1987; DuMars and Rock, "The New Mexico Legal Rights Land Grant Demonstration Project" 8 N.M.L.Rev. 1 (1977).
13. See Genealogy of Jose Antonio Vigil in Base Abstract of the Santo Domingo de Cundiyo Grant, c/o Carlos Vigil, Cundiyo, New Mexico. Weigle, Hispanic Villages of Northern New Mexico (reprint of Volume II of the 1935 Tewa Basin Study) (Lightning Tree Press: Santa Fe, 1975) 100-105.
14. DuMars and Rock, "The New Mexico...Land Grant Project" p. 14.
15. By-laws of the Santo Domingo de Cundiyo Land Grant, c/o Carlos Vigil, Cundiyo, New Mexico. Compare Apodaca v. Tome Land and Improvement Co. (NSC) 91 N.M. 591, 577 P.2d 1237 (1977).
16. In Re Santo Domingo de Cundiyo Land Grant, No. 51054 Santa Fe County District Court.
17. Cundiyo hydrographic survey, State Engineer Office, Santa Fe.
18. United States v. New Mexico 438 U.S. 696 (1978).
19. See, e.g. Wilkinson and Anderson, "Land and Resource Planning in the National Forests" 64 Or.L.Rev. 1, 230-235 (1985).
20. Hydrologist Lee Wilson of Wilson and Associates, Santa Fe, studied the Rio Hondo historical yields for the Bureau of Indian Affairs and presented his estimates at a Socorro conference. Forest Service hydrologist Bruce Simms studied the Santa Fe River basin. Neither report has yet been formally published.
21. Interview, Elizardo Vigil, Cundiyo, New Mexico.
22. Richard Frost, Aspects of Northern Pueblo Policy in the Nineteenth Century (1979) in State v. Aamodt et. al. USDC, NM.
23. For the wilderness designation, see Pub. L. 88-577, s.3, Sept. 3, 1964, 78 Stat. 891; Pub. L. 96-550, T. I, s. 102(a)(9), Dec. 19, 1980, 94 Stat. 3222. For fire, see 16 U.S.C. s. 551 (1897) and ss. 1131, 1132 (1964) and U.S. Forest Service, Forest Service Manual: Fire Management ss. 5104, 5105 (1991) and 36 C.F.R. s. 200.2
24. Creative Act of March 3, 1891, s. 24, 16 U.S.C.A. s. 471 (repealed 1976); United States v. New Mexico 438 U.S. 696 (1978).
25. Pecos Wilderness Prescribed Fire Plan, Carson and Santa Fe National Forests, April, 1988, Forest Supervisor, Santa Fe. At this writing the Southwest Region has just signed off on the controversial plan.
26. 16 U.S.C.A. 1131(c)
27. Interview, Elizardo Vigil, Cundiyo, New Mexico; Leonard, The Role of the Land Grant; Hall, "San Miguel del Bado" NMHR.
28. deBuys, Enchantment and Exploitation, 255-278; Hall, San Miguel del Bado, NMHR.
29. E.G. Light v. United States 220 U.S. 523 (1911); Taylor Grazing Act, 43 U.S.C.A. s. 315 ff.
30. Interview, Carlos Vigil, president, Cundiyo Livestock Association; Eastman and Gray, Communal Grazing: Practice and Potential in New Mexico (UNM Press: Albuquerque, 1987).

31. 5 U.S.C. 301, 36 CFR 222.3, FSM 2230.
32. Public Rangelands Improvement Act of 1978, 43 U.S.C.A. s. 1902(b); Federal Land Policy and Management Act of 1976, 43 U.S.C.A. s. 1702 (k).
33. P.L. 88-577, September 3, 1964, 78 Stat.895 (4)(2).
34. Interview, Ted Greathouse, Espanola Ranger Station, Santa Fe National Forest.
35. Interview, Elizardo Vigil, Cundiyo.
36. Interview, Sabino Samuel Vigil, Cundiyo, New Mexico.
37. The 1978 map of the Sierra Mosca Allotment shows more than 50% of the land with fair or worse range conditions. The 1935 Tewa Basin study, reprinted in Weigle, ed. Hispanic Villages of Northern New Mexico estimated 175 head of livestock grazing in the mountains east of Cundiyo. At the time the Sierra Mosca allotment was "apparently not overgrazed." Today, pressure is increasing to eliminate all grazing allotments in areas close to Santa Fe. Interview, Espanola district ranger Lori Osterstock.
38. GAO, Federal Lands: Reasons for and Effects of Inadequate Public Access (Government Printing Office, April 1992.)
39. Interview, Eloy Vigil, Cundiyo, New Mexico.
40. See Regional Forester William D. Hurst to Forest Supervisors and District Rangers March 6, 1972.

Land Grant Community Associations in New Mexico

Malcolm Ebright[1]

Abstract — With the massive loss of traditional lands suffered by Hispanics in New Mexico, and the steadily increasing role of government agencies like the Forest Service in managing former land grant ejidos, the importance of land grant community association has increased. Local community associations that speak out with a strong voice make known the concerns of the largely rural communities using forest and grazing resources as they compete with a multiplicity of conflicting interests. With this powerful voice, these communities can better negotiate forest plans and resource management policies that protect their interests.

For the purpose of this discussion, I am defining land grant community associations broadly to mean any community association dependent on a land base whether or not the association owns that land. In most eases where a rural community association does not own the land they use, the ancestors of the association members did, at one time. have title to the land. Often such land is now owned by the federal government and managed by the Forest Service or the Bureau of Land Managemental

I will discuss four community associations and try to analyze their effectiveness in serving their members. and possibly draw some lessons about the relationship between the structure of the association and its success. But first some background on New Mexico land grants is necessary. The history of New Mexico land grants prior to the U.S. occupation in 1846 differs from land tenure in Mexico in that the Hispanic community land

grant was much more common in the frontier province of New Mexicò than in the rest of Mexico.[2] These grants were in part a product of the isolation and unique topography of New Mexico As distinguished from a private grant where the entire tract was owned by one or a few individuals as private property. the community grant combined both the private property of solares, and suertes owned by each settler as house and farm lots, with the communal property of the ejido There is little documentation on how these community land i rants were managed in New Mexico, but it is clear that the Spanish and Mexican governments generally protected them and recognized local management of ejido lands for grazing and wood gathering, lt is out of this tradition that current land grant community associations were born.[3] From the beginning of United States authority in New Mexico, this tradition of community control began to be eroded and undermined With the adjudication of New Mexican land grants in the 1850's, community or ejido lands were often confirmed by the United States where the existence of a community using those lands could be proven.[4] But the community land grant had to file a petition with the Surveyor General of New Mexico under an unfamiliar legal system and if someone else filed first, the true owners—the community—often lost the land Later in the 1890's the Court of Private Land Claims was even harder on community land grants, deciding ln the famous Sandoval case[5] that ejido lands were not owned by the community at all but by the United States government. Much of the National Forest existing today in northern New Mexico was once ejido lands of community land grants or land grants rejected for other reasons.[6] Community ejido lands were also lost when community grants were divided up and sold under New Mexico's partition statute.[7]

Even after ejido lands were lost through one of these methods, most villages did not realize that they no longer owned these lands until decades after ownership had passed to the federal government or to a private individual. This was because land grant villagers were still allowed to use ejido land for grazing, wood gathering, and other uses and were not properly notified of the legal proceedings through which these ejido lands were lost. By the time they realized that their ejido was gone, it was often too late for the community to organize an effective association to fight for

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the return of these lands. Community ejido lands were often sold to a third party by this time, someone without any knowledge of the legitimate claims of the land grant villagers.[8]

The Jacona grant association was an exception to this pattern. It was able to organize before the land was sold, and to buy back its ejido lands. The Tecolote grant was confirmed as a community grant and the Cundiyó grant was confirmed as a private grant and now both are operated as community grants. The community organizations that are dependent on the Vallecitos Sustained Yield Unit for timber differ from the Jacona, Tecolote, and Cundiyó associations in that the Vallecitos communities do not have title to any of their former ejido lands.

THE TECOLOTE GRANT

The Tecolote Grant was donated in 1824 by the Mexican government as a private grant, but it was regranted as a community grant in 1838 and confirmed as a community grant by the Surveyor General of New Mexico in 1858. It was not until 1902 that a patent was finally issued to the town of Tecolote, however. During this fifty year period controversy developed over the ownership of the grant, with the heirs of the original private grant saying that they alone owned the entire grant of 48,000 acres while the inhabitants of villages on the grant claimed ownership as a community grant. Both sides were represented by lawyers and although the grant was finally declared to be a community grant this struggle over the common ejido lands of the grant has persisted in different forms and has continued to drain the resources of the community down to the present day.[9]

In 1903 New Mexico passed a law providing that every community land grant be governed by a five member board of trustees elected by the members of the grant every two years. Such a grant board has been the association managing the common lands of the Tecolote grant ever since.[10] But the board of trustees has not been able to prevent the continuing struggle between different factions for control of the ejido lands. Numerous lawsuits over the election of members of the board of trustees, over the improper sale of ejido lands by the trustees, and over claims to the ejido lands, have again required the board of trustees to hire attorneys and pay large amounts of the grant's resources in attorney's fees.[11] Part of the problems of the Tecolote grant were caused by changes in the statute concerning the powers of the board of trustees. At first the board of trustees had the power to manage and control the grant, to regulate or prohibit timber-cutting and stock-gazing on the common lands, and to lease portions of the common lands at rents to be determined by the board.[12] Then in 1927 the statute was amended to allow the board of trustees to sell portions of the common lands.[13] After 1927 lawsuits over common land ownership began, as large pieces of these lands were sold, sometimes to outsiders or even to members of the grant board. In order to prevent such abuses the statute was again changed to require any sale or lease to be approved by the district court judge.[14] This did not solve the problem however, because when sales were still made without the judicial approval a lawsuit was still necessary to set them aside.

The Tecolote grant's common lands, now comprise about 10,000 of the 48,000 acres that were patented to them almost a century ago. Members of the present board of trustees have tried to reform the inefficient management of the grants' resources with some success. Most grant members work outside the grant to support themselves and few members make use of the resources on the common lands. The grant's primary source of income is the sale of sand and gravel, but, until recently, little of this income has benefited the average grant member since much of it has gone to pay attorney's fees. Now the present board of trustees has almost stopped the outflow of common lands into private ownership, and is beginning to use grant income for projects like the rebuilding of the atarque (diversion dam for the acequia) and putting in a community well. The potential for more reform is there as community spirit on the grant improves.[15]

THE JACONA GRANT

In contrast to the problems on the Tecolote grant, the Jacona land grant and Cundiyó grants have each had better success in managing their lands. Jacona and Cundiyó are both a short distance from Santa Fe, where many of the grant members work. Both started out as private grants, later evolving into community grants. But since they were confirmed by the United States as private grants they were not subject to as much government control as is the Tecolote grant and other statutory community grants.

The Jacona grant was donated to Ignacio Roybal, a prominent Spaniard who was alcalde of Santa Fe in the early 1700's.[16] For the rest of the colonial period and the period after Mexican independence from Spain, Roybal family members were the primary occupants of the grant. By 1874, there were still only about fifty families living on the grant.[17] They hired a lawyer to get the grant confirmed by the United States, and like the Tecolote grant, they were successful. But the lawyer took one quarter of the 7,000 acre grant as his fee.[18] Then the lawyer filed suit to partition or sell the grant under the partition statue mentioned earlier. This statute was an example of the conflict between the American and the Mexican legal system. Under Spain and Mexico the common lands could not be sold,[19] but under the partition statue anyone with an interest in the ejido lands of a community grant could ask a court to physically divide the grant among its owners. If that was impractical, which it always was, then the grant's common lands had to be sold to the highest bidder

and the proceeds divided among the owners of the grant. Often under this procedure the lawyer or his partner would be the only bidders at the sale, so they would acquire the grant at a low price and then resell at a profit. The grant members would receive a small sum of money but would no longer have an interest in the common lands.[20] But in the case of the Jacona grant, the grant residents took up a collection and purchased the grant themselves when it was offered for sale. They then set up a three man commission to manage its affairs.[21]

The land grant association differed in principle from the Tecolote grant's board of trustees in that it was not limited by statute in its power to manage the grant's affairs. It could even decide whether to run the grant as a community grant with common lands owned by the community as a whole, or as a private grant with each member owning a fractional interest in the former common lands. At the beginning the grant was set up as a kind of community grant owned by the 111 individuals who contributed money for the purchase of the grant. They each had equal rights to roads, wood, and pasture and had the obligation to pay their share of property taxes on the common lands. The members could not sell their interest in the grant to anyone outside the initial group, and if they violated any of the terms of the agreement they were to be excluded from the association.[22]

The problem of non-payment of property taxes by some of the members of the Jacona grant soon caused the association to radically change its basic structure in 1919. Under the initial structure, the association was responsible for paying the entire property tax bill on the common lands and collecting from each member their share of the tax. If some members did not pay, the grant could lose the entire 6,000 acres of common lands. This happened to quite a few statutory community grants that were not able ta pay their property taxes during the Depression in the 1930's and either had to negotiate a settlement with state taxing authorities or lost their common lands to the state government.[23]

But the flexibility of the Jacona grant's structure and their resourcefulness made possible another outcome. In 1919 the members changed their basic structure by dividing the common lands among themselves so that each member received 60 1/2 acres in their name. The individual members had the responsibility of paying their own taxes and if they did not pay, only their 60 1/2 acres would be lost and not the entire 6,000 acres. This change was primarily for tax purposes, however, since on the ground it was still operated as a community grant.[24]

Nevertheless, this new structure did not solve all the tax problems of the Jacona grant. The grant still had the problem of members failing to pay their property taxes and jeopardizing their lands. Since it did not want to lose even a part of its common lands, in 1928 the grant filed suit against 46 members whose taxes were delinquent, asking the court to terminate their interests and convey them to the remaining members. When the court granted the petition, the grant was able to save most of its common lands.[25] The Jacona grant had more flexibility in running its affairs because it was owned by a fixed group of members who were not limited by government statutes or regulations. The Jacona grant has continued to be successful in operating the grant for the benefit of the members. Recently it filed a suit to clear the title to the common lands and then was able to sell a portion of those lands to a school district for a substantial sum. Now the Jacona grant members receive regular income from this sale and still retain most of their common lands.[26]

Another difference between Tecolote and Jacona is the use of lawyers by these two grants. At Tecolote, lawyers representing different factions were fighting each other in court over the common lands. No matter who won, the grant was diminished. Jacona, on the other hand, first worked to unify themselves and then found lawyers who made the system work for the land grant.

The key factor making this all possible is that the Jacona grant, like the Cundiyó grant, had a dual nature depending on whether it was looking outward or inward. Looking outward, as between the grant and the state and federal governments, it was a private grant. Looking inward, the grant was at some times and for some purposes private and at some times community. The advantage of this flexibility is that it gives both Jacona and Cundiyó a certain independence not enjoyed by statutory community grants like Tecolote. Neither the state nor federal governments have jurisdiction to establish rules for the operation of these land grants, yet when it is in their interest to invoke limited court jurisdiction, as in a suit to clear their titles or to expel non-taxpaying members, these grants have the power to do so.

New Mexico law has always been more comfortable dealing with private property interests than with common property interests. The rules for private ownership by one or a group of individuals as joint tenants or tenants in common is clear. But the courts have not been able to define so easily the property interests of the members of a statutory community land grant in the common lands. In one of the leading cases, which involved the Tecolote grant, the grant residents sought to challenge actions of the board of trustees, claiming that they resulted in alienation of the common lands without adequate compensation. The nature of plaintiff's ownership interest became an issue because it was argued that they did not have standing to bring the lawsuit since Tecolote was not an incorporated municipality. According to their reasoning, since Tecolote was not a municipality, its residents were not taxpayers to the land grant and therefore lacked standing to sue.

Judge Watson rejected this argument however, taking a more pragmatic approach in deciding the case. He said that "Tecolote was here when United States troops took possession [of New Mexico], and was recognized by the Congress more than thirty years before the common law was

adopted [in New Mexico]." Watson realized, more than have other judges, that the problem centered upon the lack of a common law model to apply to an institution that grew out of the Spanish civil law. The model of an incorporated municipality didn't work, but Judge Watson nevertheless held that Tecolote residents did have standing even if there was no common law legal theory that was adequate to explain why, simply because they had been around for a long time.[27] Here was an entity whose members were entitled to protection, said the court, even though the law had not yet figured out how to classify Tecolote.

In other cases community land grants have been called quasi-municipal corporations,[28] and most recently have been defined as a massive tenancy in common.[29] Since the law is still confused on this point, Tecolote must wait for the courts to clarify the matter. Private grants similar to Jacona, on the other hand, have used the intricacies of private vs. common ownership to their advantage, deciding on an ad hoc basis what category they fall into, but not feeling bound by any prior determination in making future decisions.

THE SANTA DOMINGO DE CUNDIYÓ GRANT

Like Jacona, the Santa Domingo de Cundiyó grant also has a somewhat schizophrenic nature but was also able to work together and hire lawyers who helped the grant achieve its goals by manipulating this duality. The key difference between these two grants and Tecolote is that Jacona and Cundiyó have control over what to call themselves, while Tecolote and other statutory community grants are subject to the vagaries of conflicting judicial holdings as to their legal nature and its effects. As a private grant operated as a community grant, Cundiyó, like Jacona, was not limited by statutory rules on how it could run its affairs.

When threatened with loss of its common lands in 1926, Cundiyó, like Jacona, united to save them. An erroneous tax assessment had caused a tax delinquency, so a committee from the grant negotiated a lower assessment with the county.[30] Then in the late 1970's Cundiyó was chosen for a title clearance project that eventually cleared the title to all of the private lands within the grant. It was its tightknit social structure and compact land base that resulted in Cundiyó being chosen for the project,[31] What made the project possible was that an expert historian testified on behalf of the grant that Cundiyó was in fact a community grant. Here again, however, it is the distinction between the inward looking view of the grant and the outward looking view that is important. It is true that, as between themselves, Cundiyó was a community grant but from an outward looking standpoint it is still a private grant.

The Cundiyó grant still has the problem of lack of control over land that was once part of the grant. Through the Cundiyó Livestock Association, it enjoys some use of the forage on land now administered by the Forest Service. But this use is at the discretion of the Forest Service. I agree with Erm Hall that the power of the local Cundiyó community over all the resources in the watershed should be increased because of the historic cultural and legal ties of the land grant to this land.[32]

THE VALLECITOS SUSTAINED YIELD UNIT

Another community organization trying to work with the Forest Service in utilizing resources on Forest Service land is La Companía Ocho, a New Mexico corporation established to provide employment to residents of the Hispanic villages within the Vallecitos Federal Sustained Yield Unit, which I will simply call the unit hereafter. Dr. Suzanne Forrest discusses the history of the unit in her paper, so I will not go into much detail about its background. The purpose of the unit is to manage the 61,000 acres of timber within its boundaries primarily for the benefit of communities in the Vallecitos area. Until the establishment of La Companía Ocho and another community based organization called the Madera Forest Products Association, there were no local community organizations capable of utilizing the timber resources on the unit. The Jackson Lumber Company, a sawmill run by someone from outside the community, was designated by the Forest Service to be the organization that the Forest Service would deal with.

During the 1950's and 1960's a series of complaints against the company charged that Jackson was importing workers and not hiring local people. In 1972, Duke City Lumber Company, the largest logging and wood products company in New Mexico, was designated as the approved operator for the unit, but the Vallecitos Sustained Yield Unit still was not operated by a local community organization.[33]

In 1988 local residents formed La Madera Wood Products Cooperative.[34] Then in 1990, La Companía Ocho was founded by more local residents to bid on logging contracts and provide employment for rural communities in the area. Based on a promise from the Forest Service of about a million board feet of timber from the unit, the founders of La Companía borrowed approximately $200,000 for the necessary heavy equipment for a logging operation. Recently however, La Companía has charged that the Forest Service has refused to provide them the promised timber and now its owners may lose their entire investment.[35]

Now that there are finally viable community organizations capable of meeting the requirements of the Sustained Yield Forest Management Act, the policy of the Forest Service often seems not to encourage and support those community organizations. Unlike Tecolote, Jacona, and Cundiyó, La Companía has no land base to fall back on and is completely dependent on what is now Forest Service land. As with Cundiyó, the Forest Service should give more power

to local community groups like La Companía. As it now stands, the future of a viable community organization hangs in the balance. If the Forest Service would give La Companía a greater voice in the management of the Vallecitos Sustained Yield Unit then it will probably survive. But if the Forest Service retains absolute discretion in timber allocation on the unit, then La Companía will probably fall.[36]

That would be especially tragic in this period of New Mexico's and the nation's history. Recently, at President Clinton's forest summit conference in Portland, the need to recognize the importance of jobs and investment when striking the balance between ecology and economics was stressed. If La Companía fails then both jobs and investments will be lost. If La Companía and La Madera Wood Products Cooperative are to survive and prosper they need to be treated as owners of the unit, whose interest is being managed by the Forest Service as a trustee, since it was their land before the Forest Service arrived on the scene.

In fact the Forest Service implicitly recognizes this claim. Its policy on managing national forests in northern New Mexico, adopted in 1972 and still in effect, states that Hispanic culture and Hispanic communities should be protected and preserved. This is true, says the policy, because of the historic ownership of much of northern New Mexico forests as land grants. Therefore these communities need recognition and protection as a precious resource much the same as wilderness is in need of protection as a resource.[37] If that policy means anything, then La Companía, Madera Forest Products Association, the Cundiyó Livestock Association, and other similar community associations must be given more control over the resources—timber, grass, and water—that they are dependent upon.

New Mexico's State Historian Robert Torrez quoted Niccolo Machiavelli in his paper to the effect that men are quicker to forget the death of a father than the loss of a patrimony.[38] I would simply add to that three maxims for land grant community organizations that, if Machiavelli didn't say them, it still seems like sound advice. One: stay away from lawyers, unless they are working for your interests. Two: stay flexible so that you can use the system for your benefit, rather than have the system destroy you. And third: never let them forget that this was once your land.

ENDNOTES

1. In recent testimony at a congressional hearing on the status of community land grants in northern New Mexico, the U.S. Forest Service estimated that 714,000 acres of New Mexico's national forests were formerly Spanish arid Mexican land grants. Testimony of Regional Forester David F. Jolly. Santa Fe, October 11, 1988, in Oversight Hearing...on the Status of Community land Grants in Northern New Mexico (Washington, D.C.: U.S. Government Printing Office, 1989), p. 59.
2. Ian Jacobs, Ranchero Revolt: The Mexican Revolution in Guerrero (Austin: University of Texas Press, 1982), p. 41
3. See generally, Daniel Tyler, "Ejido Lands in New Mexico," in Malcolm Ebright, ed., Spanish and Mexican Land Grants and the Law (Manhattan, Kansas: Sunflower University Press, 1989), p. 24; Malcolm Ebright, "The San Joaquin Grant: Who Owned the Common Lands? A Historical-Legal Puzzle," New Mexico Historical Review 57 (January 1982).
4. This rule was established for California land grant adjudication. (9 Statutes 634, Section 14, 1851), and was followed by the surveyor general of New Mexico.
5. U.S. v. Sandoval, 167 U.S. 278 (1897).
6. The region 3 Forest Service policy estimates that 22% of the Carson and Santa Fe National Forests were once land grant lands. Region 3 Policy on Managing National Forest Land in Northern New Mexico, Albuquerque, 6 March 1972.
7. New Mexico Laws (1875-1876), Chap. 3 codified in Sec. 42-5-1 to 42-5-9 N.M.S.A. (1978).
8. Malcolm Ebright, The Tierra Amarilla Grant: A History of Chicanery (Santa Fe: The Center for Land Grant Studies, 1980). p. 27. n. 70: William de Buys, "Fractions of Justice: A Legal and Social History of the Las Trampas Land Grant, New Mexico,"New Mexico Historical Review (hereinafter NMHR) 56 (January 1981) 71-97.
9. Salvador Montoya to the alcalde constitutional del Bado, San Miguel del Bado, 8 October, 1824. New Mexico Land Grants Surveyor General (hereinafter NMLG-SG), Roll 13, report 7, frames 7-8: GLO to Surveyor General Clarence Pullen, Washington, D.C., 1 April 1885, NMLG-SG, Reel 12, report 7, frames 242-48: Spanish Archives of New Mexico, series I hereinafter SANM I) 1116: J.J. Bowden, "Private Land Claims in the Southwest," 6 vols. (L.L.M. thesis, Southern Methodist University, 1969), 3:730.
10. Section 49-10-1 through 49-10-6 New Mexico Statutes Annotated (hereinafter NMSA).
11. Beatriz M. Garduno, "Tecolote Land Grant" (unpublished manuscript), pp. 17-36.
12. Acts of the Legislative Assembly of the Territory of New Mexico, Sec. 5, Chap. 77 (1903).
13. Section 9-1005 N.M.S.A. (1941 compilation)
14. Section 49-10-5 N.M.S.A. (1992 compilation)
15. Interview with Joe I. Herrera, president of the board of trustees of the Tecolote land grant, 5 May 1993.

16. SANM I, nos. 487, 488, and 1339. Alfred Barnaby Thomas, After Coronado (Norman: University of Oklahoma Press, 1935), pp. 106 and 253-54, Chavez, New Mexico Families, pp. xii, 273-275.
17. Affidavit of Jesus Maria Ortiz before Surveyor General Proudfit, 5 June 1874. NMLG-SG, Roll 22, report 92, frames 362-63.
18. Authorization signed by Desiderio Gromez, Camilio Martin, and Anastaslo Gomez, Santa Fe, 13 June 1893. NMLG-PLC, Roll 36, case 35, frame 515.
19. Mariano Galvan Rivera, Ordenanzas de Tierras y Aguas (Mexico, 1849). p. 187.
20. de Buys, "Fractions of Justice," p. 84.
21. The commission was also referred to as title trustees of the Jacona grant or the board of directors of the Jacona grant. Quitclaim Deed to Nicacio Gallegos, 5 June 1952, recorded at Book 66, p. 94, Santa Fe Community Deed Records: Lease to Manuel Roybal, 1 February 1954, recorded at Book 92. p. 289, Santa Fe County Miscellaneous Documents.
22. Agreement and Power of attorney, 18 June 1909, recorded at Book Santa Fe County Deeds, p. 184.
23. G. Taylor, "Notes on Community-Owned Land Grants in New Mexico," (unpublished manuscript, Soil Conservation Service, August 1937), passim.
24. Partition Deed, 25 February 1919, recorded 27 February 1919 in Book C, p. 514, Santa Fe County Contracts.
25. Complaint in Santa Fe County District Court cause no. 13032 filed 7 May 1928, and Final Decree filed 19 October 1928.
26. It is interesting to compare the limiting of membership on the Jacona grant with the Cundiyó grants' limitation to 41 memberships and its prohibition of any subdivision of those memberships. Em Hall, "Community Land Grants and the Forest Service as Watershed Managers: The Example of Santa Domingo de Cundiyó," (another paper included in this volume), note 17 and accompanying text.
27. Kavanaugh v. Delgado 35 N.M. 141 (1930).
28. N.M. v. Board of Trustees of the Town of Las Vegas, 28 N.M. 237 (1992).
29. Mondgragon v Tenoria, cause no. 10194, Federal District Court. 554 F2d 4:33 (l0th Circuit, 1975).
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32. Hall, "Santa Domingo de Cundiyó," n. 42 and accompanying text.
33. David A. Clary, Timber and the Forest Service (Lawrence: University Press of Kansas, 1986), pp. 132-136.
34. Luis Torres, "Madera Forest Products Association," The Workbook, 14 (Jan. - Mar. 1989): 5-7.
35. Interview with Antonio de Vargas, Servilleta Plaza, New Mexico, April 15, 1993; Amended Motion to Intervene filed by La Companía Ocho in Wilderness Society v U.S. Forest Service, civil cause no. 91-1306, U.S. District of Arizona.
36. Forest advisory boards regarding grazing were first recommended in 1905, see William D. Rawley, U.S. Forest Service Grazing and Rangelands (College Station: Texas A & M University Press, 1985), p. 57. For a discussion of current Forest Service controversies and their background see Charles F. Wilkinson, Crossing the Next Meridian: Land, Water, and the Future of the West (Washington, D.C.: Island Press, 1992), pp. 114-174.
37. Region 3 Policy on Managing National Forest Land in Northern New Mexico, Albuquerque, 6 March 1972, Albuquerque.
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The Vallecitos Sustained Yield Unit: A New Deal Legacy

Suzanne S. Forrest

Abstract — The Vallecitos Federal Sustained Yield Unit, established January 21, 1948 in the Carson National Forest in northern New Mexico as part of the Sustained Yield Forest Management Act of 1944, has been in existence forty-five years. Unlike most other Forest Service sustained-yield programs, its primary purpose is to provide maximum feasible support for the forest dependent communities located within or adjacent to its borders. Approved operators receive monopoly rights over the timber in exchange for providing a continuous source of employment for local residents. The only one of its kind still in existence, the VFSY Unit has been the source of continuous controversy. Lumber Companies have found the restrictions placed upon them to be obstacles to cost effective operation. The Forest Service has found administration difficult, and has tried on many occasions to abolish the Unit. It has not been able to do this without the consent of the Vallecitos residents. The residents, though frequently disillusioned and angered by a lack of compliance and respect for employee rights on the part of the Lumber Companies, have clung fiercely to the Unit and the promises written into the enabling legislation. Though all parties have found the organization to be less than satisfactory, each has had to compromise in ways that ultimately serve the interests of both the people and successful sustained yield forest management.

On January 21, 1948 Congress authorized the creation of the Vallecitos Federal Sustained Yield Unit on the El Rito Ranger District of the Carson National Forest in northern New Mexico. The Unit included approximately 73,400 acres of national forest, of which about 61,400 acres was classed as suitable timber land. In addition to providing multiple-use benefits as derived from the National Forest as a whole, the purpose of the unit was to stabilize three small forest-dependent communities by providing them with steady employment opportunities and a permanent supply of timber for their own local needs. To further this goal, exceptions to competitive bidding were authorized and timber was sold at appraised value. Additional support was provided by requirements specifying that primary manufacturing was to be performed with the Unit, and that most employees were to be local residents. A final requirement specified that all decisions concerning sales and designated responsible operators, as well as any changes in policy governing the unit, were to be preceded by public notice and a hearing before the local residents.[1]

Forty-five years after its founding the Vallecitos Federal Sustained Yield Unit is still in existence. Throughout its history it has been a source of almost continuous controversy. From the stand point of the lumber companies, the unit has been a frustrating obstacle to the cost and labor efficiency of their operations. Forest Service personnel, charged with selecting approved operators and overseeing their compliance with the policies that created the Unit, have been caught in a crossfire of demands by the local Hispanic population, pressures from the approved lumber companies, and their Service's own changing priorities. They have vacillated between firm support and pride in the Unit and utter exasperation at its apparent failure. The Vallecitos villagers, for whom the unit was created, have often been

angry and disillusioned, but they have held tenaciously to the rights promised them in the founding legislation. They have resisted fiercely every effort to terminate or substantially modify the policies governing the Unit's administration. A review of this history provides us with an interesting overview of the problems, successes, and challenges of this human dimension to sustainable forest management.

To start at the beginning, the Vallecitos Federal Sustained Yield Unit came about through the enactment on March 29, 1944 of Public Law 273, known as the Sustained Yield Forest Management Act. This Act authorized the Secretaries of Agriculture and Interior to create two kinds of Sustained Yield Units, both of them designed to stabilize forest industries while simultaneously stabilizing permanent communities of forest workers dependent upon them for their livelihood. "Cooperative units," provided a means of merging the management of public and private lands so as to increase the resource base of local lumber companies. "Federal units" reserved national forest timber in given areas for the exclusive use of local operators. Both kinds of units permitted the sale of timber within units to private companies on a basis of periodically appraised value rather than the usual competitive-bid procedures, in essence giving these companies a monopoly over the national forest timber in their area.[2]

The concern for the nation's natural resources combined with a concern for its resource-dependent communities marks the Sustained Yield Forest Management Act as the offspring of a broad based program known informally as the Community New Deal. Although based philosophically in the belief that the nation's moral and economic strength depended upon the vitality of its small towns and rural populations, the Community New Deal had a compelling economic component. The country could not afford to lose any more of its rural industries to the reckless exploitation that, by the 1930s, had devastated thousands of acres of timber lands and turned the western grasslands into a gigantic dustbowl. Neither could it afford to displace large numbers of farmers, ranchers, and loggers from the national economy. The framers of this legislation, David T. Mason and Edward T. Allen of the Western Forestry and Conservation Association, drew upon industrial support in Congress for the passage of their bill with little encouragement from the Forest Service. Nevertheless their interpretation of sustained yield was not incompatible with that of sustaining the productive capacity of the forests. How better to accomplish these twin goals than by educating and empowering the people whose lives depended most directly upon these natural resources to become responsible stewards?[3]

No place in the country was hit harder by the Great Depression than northern New Mexico. Among those most devastated were rural Hispanic families that had formerly supplemented their meager farm incomes with migrant labor. Most of them had also lost title to their communal grazing and forest lands and so were left virtually without resources. Since the Forest Service fell heir to thousands of acres of these old Spanish and Mexican land grants, many Hispanic villagers now lived within or adjacent to the national forests.

As in many Western states, decades of abuse and misuse of New Mexico's land and water resources greatly compounded the business depression. Fortunately, the Roosevelt New Deal brought an array of federal programs designed to stabilize these devastated resources along with the communities that had depended upon them. The programs provided desperately needed employment, education and materials for forest dependent Hispanic villagers, but Forest Service officials worried about the time when the New Deal programs would no longer be in existence.[4]

As early as November 1940 the "Management Plan for the Tres Piedras-Vallecitos Working Circle," specifically mentions twelve small Hispanic communities dependent upon the forest for much of their living. The objects of forest management, according to this plan, were to produce logs, ties and other forest products on a sustained yield basis so as to protect watershed values, favor recreational development (though no substantial development of this kind was anticipated on the circle), and *provide seasonal employment for local labor* at a fairly constant rate in order to stabilize these communities.[5]

The Vallecitos unit was created as soon after the end of World War II as possible. Based on statistics gathered for the 194O Tres Piedras-Vallecitos Working Circle, the Management Plan for the Vallecitos Federal Sustained Yield Unit called for aggressive action to provide employment for the people of Vallecitos, Canon Plaza, and Petaca.[6]

The policy statement prepared for the unit in 1948 leaves no doubt as to its goals. It reads as follows:

> *The primary purpose for establishment of the Vallecitos Federal Sustained Yield Unit is to provide the maximum feasible, permanent support to the Vallecitos community and nearby areas, including Petaca and Canon Plaza, from forest products industries obtaining a timber supply from the national forest lands of the Unit. Timber from the Unit will, therefore, be sold under conditions designed to promote the following objectives:*
>
> *1) Maintenance of steady employment opportunities in the Vallecitos community and nearby areas both within each year and from year to year.*
>
> *2) Employment of local labor.*
>
> *3) Opportunity for those living within and near the Unit to obtain lumber for their local requirements.*
>
> *4) Efficient operation and maintenance of, and additions to, plant facilities to keep them in step with technical advances in forest products utilization and manufacture which are feasible for adoption under the economic conditions of the northern New Mexico area.*

In order to provide these conditions, the policy further required that: 1) all national forest timber sold from the Unit must be given primary manufacture in or within one mile of

the village of Vallecitos except, with the approval of the Regional Forester, a) minor amounts of special products, or b) salvage material which cannot be given primary manufacture within the Unit before it deteriorates; and 2) Timber may be offered for sale to an approved responsible operator or operators maintaining suitable manufacturing facilities at Vallecitos in such amounts and at such times as are approved by the Regional Forester.[7]

In accordance with regulations set forth in the Sustained Yield Management Act, Forest Service officials notified local landowners of their intent to create a sustained yield unit in November, 1947. The same letter, written in both Spanish and English, also announced a public hearing to explain the matter in detail. More than 100 local residents turned out on a cold snowy day in December to hear about the unit, to make comments and to ask searching questions concerning its impact on "the poor people." Their primary concerns were that outsiders, rather than local people, would be benefitted, and that the timber stand would be depleted. When satisfied that the Forest Service had their best interests at heart, they approved the unit without dissent. Shortly thereafter the Forest Service named the Vallecitos Lumber Company as the approved designated operator.[8]

Despite what appeared to be an auspicious beginning, problems in compliance with the requirements of the Unit surfaced almost immediately. The Vallecitos Lumber Company failed to move its sawmill to a new location near Vallecitos and establish a remanufacturing plant. Its contract was canceled in September, 1948. In November, 1949, a logging company with a sawmill immediately west of Vallecitos bought timber in the Unit under competitive bidding. It asked to be named the designated responsible operator, but the request was denied when the owner failed to demonstrate that he was able to provide the required product remanufacture. It was not until October, 1952, that the Forest Service approved the Jackson Lumber Company as responsible operator on the basis of its having built a mill and installed a finishing plant adjacent to Vallecitos.[9]

In the meantime, United States politics had undergone a sea change. Roosevelt and Truman were gone, and a conservative President Eisenhower and an equally conservative Congress presided over a nation-wide effort to roll back the "socialistic" programs of the New Deal. In keeping with the policy of making the services pay for themselves, the Forest Service conducted an inventory of the timber within the Unit in 1952 and raised the annual sustained yield cut from the original one and a half million board feet to three and a half million board feet. The Unit was reauthorized with the original mandate, but new and obvious efforts to clarify and enforce the employment requirements reflect a degree of frustration on the part of the Forest Service in getting operators to comply with the provisions having to do with community support. The expanded policy statement called for the full allowable sustained-yield cut to be given primary manufacture at Vallecitos along with 60 percent of the planing; as much timber from sources outside the Unit as possible were to be milled at Vallecitos; the lumber from the Unit was to be sold to local people at the "regular" price; the operation was to continue for at least nine months of the year; at least 35 men were to be employed in the combined logging and milling operation; and at least 90 percent of those employed were to be from the communities named in the policy statement.[10]

A good many of the problems with the Sustained Yield Unit appear to have revolved around the employment of "local residents." For a variety of reasons, Jackson Lumber often hired workers from beyond the borders established in the policy statement. In some cases it hired skilled workers from beyond the area or non-Hispanic workers who had only recently settled in the community. It also hired workers, with the approval of the Forest Service, from neighboring Hispanic communities not specified in the VFSYU management plan.[11]

Thoroughly disgruntled over what they perceived to be unfair employment practices, the residents of Vallecitos exercised their right to express their views in a public hearing held August 29, 1956. They were met by equally disgruntled Forest Service officials who contended that the lack of competitive bidding for National Forest timber resulted in a loss of revenue to Federal and county treasuries. If the Unit were abolished, they argued, it would not only eliminate controversies over employment, but guarantee a continuing industry in the Vallecitos area in keeping with the free enterprise system.[12]

The Vallecitos residents would have nothing to do with these arguments. More determined than ever to keep the Unit and its policies intact, they called for help from Senator Dennis Chavez. He met with representatives from the Forest Service, the Jackson Lumber Company, and representatives of the Vallecitos labor force in his office on September 7, 1956 and proposed a compromise that was accepted by all parties. As a result of this meeting the Sustained-Yield Unit was continued with the following adjustments: 1) an advisory board of local citizens would be appointed by the Forest Supervisor to review all employee lists and requests for exemptions based on the non-availability of competent local laborers and make recommendations to the Forest Supervisor on a monthly basis; 2) 76 percent of workers would be selected from employment area (A), to include the original three communities plus two others; with 90 percent from an expanded employment area (B) including three more area communities. The Jackson Lumber Company agreed in principal to the compromise proposal, but did not stay to abide by it. In May, 1957 its mill burned and, rather than rebuild its facility, it discontinued operations in the Vallecitos Unit. The Forest Service revoked its contract the following October.[13]

Nine years passed with virtually no activity within the Unit. In November 1966 the Forest Service again desired to abolish it, but it hesitated to call the required public hearing

with the Vallecitos residents for fear of a repeat of the last contentious session—or worse. The political climate had again changed, and there was a new concern for the economic and civil rights of the nation's minorities. On the national level President Lyndon Johnson had initiated a "War on Poverty" that, like the New Deal, brought an influx of federal money and government officials to rural America. On the local level, a Chicano activist named Reies Lopez Tijerina was stirring up the long festering land grant issue by contending that the Carson National Forest was ejido (communal village) land that should be returned to its former Hispanic owners. He incorporated an organization known as *La Alianza Federal de Mercedes* (the Federal Alliance of Land Grants), and on October 15, 1966, with 35O followers, "occupied" a national forest campground a few miles distant from the Vallecitos area. The series of events that followed led to Tijerina's being sentenced to three years in a federal penitentiary, but the movement he started did not die when he departed the scene. In New Mexico the land grant issue continued to be the focus of Chicano civil rights activism, and the last thing the Forest Service wanted was to stir up more resentment among the state's Hispanics.[14]

The Vallecitos residents, frustrated and angered by the lack of activity--and jobs--on the Unit, took matters into their own hands. They requested a hearing in September, 1967 to ask permission to start their own locally-owned lumber operation. Father Robert Garcia, of the State Office of Economic Opportunity, was present and offered them the assistance of his office in organizing and financing a cooperative. Representatives from another New Mexico Poverty Program known as H.E.L.P (Home Education Livelihood Program) offered to contact a manufacturer of rustic prefabricated fences to determine if there was a market for such a product. In his report of the meeting, District Ranger Jack Miller noted that the Forest Service wanted local leaders to take the initiative in developing action programs. With or without such encouragement, the Vallecitos residents were indeed organizing. Shortly thereafter, they formed the Vallecitos Federal Sustained Yield Unit Association.[15]

If the Forest Service was reconciled to the continuation of the Unit, Duke City Lumber Company, the next operator to bid for work on the Unit, was not. Its president argued that the Unit's allowable cut of three and a half million board feet was insufficient to sustain a complete operation. He preferred to transport the lumber to Duke City's central plant in Espanola, and contended that this was more economical and safer than processing the logs in the circular-type sawmill at Vallecitos. If the Vallecitos people would agree to terminate the Unit, he would help them set up their own logging operation and buy the logs. If they agreed to set up a joint venture, he would help with the financing for a share of the profits. He accused the Forest Service of abdicating it resources management responsibilities and yielding to "town meeting" pressures, but conceded that if "forced" to, Duke City would establish a sawmill in Vallecitos.[16]

In a united show of force, the Vallecitos residents refused to approve any development program that threatened to modify or do away with the Unit. After prolonged discussions with the Forest Service, Duke City gave in and admitted that the problems were not insurmountable. It submitted a formal request to be named responsible operator, and Tony Jaramillo, Vallecitos postmaster and president of the VFSYU Association, called for the mandatory public meeting. The local people voted their approval only when convinced that Duke City would comply with the objectives set forth in the Sustained Yield policy statement. The contract was awarded formally in April, 1972.[17]

In the meantime, civil rights concerns were affecting officials in the Forest Service. Early in March William D. Hurst, Regional Forester, sent what can only be described as an impassioned memo to W.R. Snyder, Carson Forest Supervisor. Snyder sent copies of the memo, which included Hurst's proposed policy for managing the national forest in northern New Mexico, to all District Forest Rangers. In endorsing the policy Snyder added: "*I firmly believe...that our success or failure in Northern New Mexico will be based upon our ability to recognize the unique qualities of both the land and the people that we are dealing with*" (Snyder's italics). The Carson must not be run as a bureaucracy: we must prepare ourselves to be fair and have the time to listen to people when they want to talk...We are not going to give anything away, but...we are going to make our resources stretch as far as they possibly will in meeting the needs in this part of the country."[18]

Hurst's Policy Statement described the poverty of the area and its lack of commercial resources to provide for the native Indian and Hispanic residents. The people, he noted, had deep roots in the land. Twenty-two percent of the Carson and Santa Fe National Forests were former Spanish and Mexican grant lands, and "in the eyes of many, their rightful owners were unjustly deprived of these properties." Unrest on the part of the native people, Hurst added, had been prevalent since 1848 when the United States gained control over the area. It had been manifested in periodic uprisings and was now making itself felt through civil rights organizations. Forest Service policy would have to be adjusted to meet this challenge. The uniqueness and value of Spanish American and Indian cultures must be recognized as "resources" much as wilderness was considered a resource. "There is no middle ground," Hurst concluded. "Failure to meet this challenge will mean conflict, frustration and a loss of prestige to both the Forest Service and the Department of Agriculture."[19]

These good intentions did nothing to ease labor problems within the Vallecitos Federal Sustained Yield Unit. Representatives of the VFSYU Association charged that Duke City violated Unit policy by hiring non-landowning "Hippies." They asked for the number of exempt positions to be grossly reduced, if not eliminated, and for local people to be trained in the higher paying skilled jobs that were exempt from the local hiring policy. To enforce their concerns, they refused to approve a major timber sale until some action was taken on their demands, presumably knowing that the delay would mean a probable reappraisal of the value of the timber and a cost increase to Duke City. The Forest Service offered to help them secure training through the approved operator, Duke City Lumber. Duke City, though it argued that nothing in its contract as approved operator required it to provide such training, agreed to the request, probably to get on with the sale, but also because specialized training funds were available from the Employment Security Commission through the Manpower Defense Training Act.[20]

By 198O national civil rights activism had passed into history. A socially and fiscally conservative administration under President Ronald Reagan brought new Forest Service policies to both the national and local level. The Forest Service plan issued May, 1984 noted that the allowable sale quantity on the Vallecitos Sustained Yield Unit had risen over the years from 1.2 to 4.2 million board feet. A recent reassessment had indicated that the biological potential of the Unit was approximately 9.5 million board feet.[21]

The potential of a vastly increased cut meant more employment for local people, but Vallecitos residents were outraged. Many of them considered the earlier allowed cut too high, convinced that this much pressure on the forest would endanger its sustainability and threaten both the watershed and their entire rural lifestyle. They circulated a petition in protest. When the Forest Plan was published the allowable sale quantity was set at 7.6 million board feet; 5.5 million of which were to be in saw timber to Duke City, the designated responsible operator, with an additional 2.1 million of saw timber and timber products to two other responsible operators. Just who the other responsible operators were is evident in the revised policy statement that now provided local residents with an opportunity to establish a wood products business.[22]

A public hearing was called for June 4, 1985 to approve the new Forest Plan and consider whether the Unit should be reauthorized. Vallecitos residents approved of the new provision encouraging them to develop their own forest products business, but protested the enlarged cut as well as a plan to build more high standard roads into the Unit. They also protested the fact that were paid less for the same type, quantity and quality of work than workers at the Duke City sawmills in Espanola, Cuba and Albuquerque; and that they received none of their employee benefits. When the Forest Service again suggested discontinuing the Unit they remained adamant in its support.[23]

The years since the Unit was last authorized have seen a number of positive developments on the Vallecitos Federal Sustained Yield Unit. In April, 1988 a group of local residents organized and incorporated the La Madera Wood Products Cooperative to cut and sell fuel wood, vigas, latillas and other forest products. Two years later in May 1990 another group of residents pooled financial resources and logging equipment and founded their own logging company, which they named La Compania Ocho. They contracted with Duke City Lumber Company to buy their timber and, when disputes arose over various contractual matters, principal among which was the way they were compensated for their lumber, La Compania filed suit and took Duke City to court. Arbitration proceedings took place in November, 1990, and concluded with La Compania being awarded $253,500 in damages. The compensation was but a fraction of the amount requested by La Compania, but the loggers were pleased with their victory.[24]

What is there to be learned from this long history of conflict, confrontation and compromise? It would be easy to conclude that the Unit is a dismal failure, since it seems to have pleased no one. Clearly, both the Forest Service and the various approved operators have found the requirements put into the original legislation to be obstacles to their goal of efficient, cost effective management. The approved operators would surely never have provided training and employment to residents of the local communities had they not been required to do so. But northern New Mexico is the stronger for having these trained workers and employment resources, and the companies are not visibly the worse for having fulfilled this need.[25]

The Forest Service has expended hours of employee time and reams of paper in its efforts to keep all parties working compatibly together. The requirement that forest service officials listen to the needs and concerns of the local residents, and work out compromises with them, cannot fail to have been an educational experience for everyone involved. This required community interaction has to have had a salutary effect on the bureaucracy, keeping it in touch with the human dimension of natural resource management.

As for the Vallecitos villagers, their lives have not been greatly improved for all their expectations and the hours of fighting for the rights they believed were granted to them. They argue that Forest Service management has failed to provide them with the kinds of advocacy action that would have permitted them to reach their full potential. But, without the employment requirements written into the establishment of the Unit, many of those now living in the area would

have had to leave, or live on welfare, with all of the unhappy consequences that kind of dependency engenders. Instead, through having been empowered from the very beginning with the right to have a say in the management of the Unit, they have developed much needed vocational, organizational, and management skills—skills that should carry them to a more rewarding future if they receive the full cooperation and help of the Forest Service. They have also been able to remain on their ancestral lands, within the comforts of their traditional culture. They look forward to passing this legacy on to their children, along with the healthy forest that will insure their future. The forest, the mute fourth party to the agreement, appears to be the better for their concerned stewardship.

ENDNOTES

[1]Sustained-Yield Forest Management Act of 1944, 58 Stat. 132. Carson National Forest Files, Taos, New Mexico. Vallecitos Federal Sustained Unit File 2410, (hereinafter referred to as USFS Vallecitos File 2410).

[2]Sustained-Yield Forest Management Act of 1944, 58 Stat. 132. Roy O. Hoover, "Public Law 273 Comes to Shelton, Implementing the Sustained-Yield Forest Management Act of 1944," Journal of Forest History, April (1978): 87-101; David A. Clary, "The Forest Service, Community Stability, and Timber Monopoly Under the 1944 Sustained-Yield Act, Journal of Forest History, January (1987): 4-18; David A. Clary, Timber and the Forest Service (Lincoln, NE: Un. of Nebraska Press, 1986), pp.126-136.

[3]Clary, David A. 1987. What Price Sustained Yield? The Forest Service, Community Stability, and Timber Monopoly Under the 1944 Sustained-Yield Act. Journal of Forest History. 31 (1):4. For an extensive discussion of the origins and implementation of America's Community New Deal see Paul Conkin, Tomorrow a New World: The New Deal Community Program (Ithaca, N.Y.: Cornell University Press, 1959).

[4]Forrest, Suzanne. 1989. The Preservation of the Village: New Mexico's Hispanics and the New Deal. University of New Mexico Press. Albuquerque, NM. pp.137, 163-66, 159-60.

[5]Thomsen, Walter G. 1940 Management Plan for the Tres Piedras-Vallecitos Working Circle, Carson National Forest, Region Three. USFS Vallecitos File 2410.

[6]Duncan M. Lang to Carson Forest Supervisor 27 Sept.1946. C. Otto Lindh to Carson Forest Supervisor, 4 Nov. 1946. P.V. Woodhead to Chief, Forest Service, 27 March 1947. USFS Vallecitos File 241O.

[7]Policy Statement for Vallecitos Federal Sustained Yield Unit, Carson National Forest, Southwestern Region, 7 April 1947. USFS Vallecitos File 241O.

[8]Letter sent in English and Spanish to all landowners within VFSYU, Nov. 1947. Public Hearing on Forest Management. News Release, 7 Nov. 1947. Pedro Martinez to Regional Forester, 21 Nov. 1947. Report on Hearing on the Proposed Establishment of the Vallecitos Federal Sustained Yield Unit held 9 Dec. 1947. Title 36 Parks and Forest. Sec. 221.33 Declaration of Sustained Yield Unit, Vallecitos Federal Sustained Yield Unit. 21 Jan. 1948. Statement of the Regional Forester at Hearing to Consider the Vallecitos Federal Sustained Yield Unit to be Held at Vallecitos, NM, August 29, 1956. USFS Vallecitos File 2410.

[9]Statement of Regional Forester, August 29, 1956. USFS Vallecitos File 2410.

[10]Statement of Regional Forester, August 29, 1956. USFS Vallecitos File 2410.

[11]Statement of Regional Forester, August 29, 1956. USFS Vallecitos File 2410.

[12]Statement of Regional Forester, August 29, 1956. USFS Vallecitos File 2410.

[13]Richard E. McArdle, Chief, FS to Jackson Lumber Company, Vallecitos, NM 8 Jan 1957. Fred H. Kennedy, Regional Forester, to Chief, FS, 25 Nov.1958. History of the Vallecitos Federal Sustained Yield Unit, n.d. USFS Vallecitos File 2410.

[14]Peter Nabokov, Tijerina and the Courthouse Raid, Albuquerque, UNM Press. Regional Forester to National Forest System, 1O Aug. 1967. USFS Vallecitos File 241O.

[15]Jack R. Miller, District Forest Ranger to Carson Forest Supervisor. 26 Jan. 1968. USFS Vallecitos File 2410. Information on the efforts of the Vallecitos residents to organize comes from Ikey DeVargas, member of La Compania Ocho; Luis Torres, a former employee of the Southwest Research and Information Center and now an independent community organizer living in Espanola; Steve Chavez, president, and Delbert DeVargas, board member, of La Madera Wood Products Coop.

[16]Yale Weinstein, President, Duke City Lumber, to District Forest Ranger 29 Jan. 1968. Yale Weinstein to M.J. Hassell, Carson National Forest Supervisor, 18 April 1968. USFS Vallecitos File 2410.

[17]T.W. Koskella, Deputy Regional Forester to Forest Supervisor, 27 May 1969. Yale Weinstein to M.J. Hassell, 16 Sept. 1969. Hassell to Weinstein, 7 April 1971. Weinstein to Hassell, 6 Aug. 1971. Koskella to File, 11 Jan. 1972. John F. Hutt, Timber Staff Officer to File. 23 Feb. 1972. Wm. D. Hurst, Regional Forester to Weinstein, 4 April 1972. USFS Vallecitos File 2410.

[18]W.R. Snyder, Forest Supervisor to Forest Rangers, 13 March 1972. USFS Vallecitos File 2410.

[19]William D. Hurst, Regional Forester, to Forest Supervisors and District Rangers. March 6,, 1972. "Region 3 Policy on Managing National Forest Land in Northern New Mexico." USFS Vallecitos File 2410.

[20]John S. Crellin, Deputy for Resource Management to Tony Jaramillo, VFSYU Association, 4 March 1975. W.R. Snyder, Forest Supervisor, to Regional Forester, 9 April 1975. Gordon R. Struthers, Foresters, to File, 24 April 1975. John F. Hutt, Timber Staff Officer, To Forest Supervisor, 5 May 1975. USFS Vallecitos File 2410.

[21]Carson Forest Plan of May, 1984. USFS Vallecitos File 2410.

[22]Carson Forest Plan of May, 1984. USFS Vallecitos File 2410.

[23]Notice of Public Hearing on June 4, 1985. John C. Bedell, Forest Supervisor, to Regional Forester, 5 May 1986. Bill Richardson, Member of Congress, to Kika de la Garza, Chair, House Agriculture Committee, Washington, D.C. 7 May 1986. Rudy J. Jaramillo, President, VFSYU Association to Bill Richardson, 1 May 1986. USFS Vallecitos File 2410.

[24]Verbal testimony from Ikey DeVargas, board member of La Compania Ocho, 11 April 1993. The author of this report was a witness for the prosecution in the arbitration proceedings and testified concerning the origins and purposes of the Vallecitos Federal Sustained-Yield Unit.

[25]According to Gordon Struthers, District Timber Manager, in a letter written to the editor of the Journal of Forest History , 7 April 1987, the timber industry brought a payroll of $450,000 to the Vallecitos community in 1986.

EL MANEJO FORESTAL EN LA ZONA TEMPLADO-FRIA

Carlos Rodriguez F., Reynaldo Valenzuela Ruiz, and Xavier Musalem L.[1]

INTRODUCCION

Los antecedentes más antiguos en manejo forestal en el mundo, se han desarrollado en Europa, desde finales del siglo XVIII y principios del siglo XIX, con la creación de las primeras instituciones de educación forestal, en países como Francia, Alemania y Suiza.

Las técnicas inicialmente desarrolladas tuvieron como meta el aprovechamiento y valoración de bosques, con la finalidad de obtener un rendimiento sostenido, contínuo, permanente y máximo acorde a las caracteristicas productivas del lugar, especies y técnicas silvícolas utilizadas, siendo este el concepto del bosque normal.

Para alcanzar el objetivo anterior, desde ese tiempo a la fecha, se ha tenido un gran avance en las ciencias forestales, en aspectos que cubren una gama amplia del conocimiento que varia de las técnicas para la identificación y clasificación de plantas hasta el desarrollo de técnicas de simulación y optimización de manejo de bosques.

Lo mencionado, ha sido desarrollado durante bastante tiempo a través del estudio de sitios permanentes y temporales de muestreo y el uso de técnicas de reconstrucción de rodales, lo que ha permitido la obtención de modelos de predicción del comportamiento de ecosistemas para diversas especies y condiciones de crecimiento, lo que aunado a técnicas de programación lineal y dinámica entre otras y el uso de técnicas de evaluación financiera, conjuntamente con técnicas de computación ha derivado en técnicas de valoración de diferentes alternativas de manejo forestal, para optimizar la toma de decisiones en el aprovechamiento y manejo de recursos forestales.

Este gran avance en la dasonomía, ligado a las mayores superficies arboladas del mundo como la Ex-Unión de Repúblicas Socialistas (EX-URSS), America del Norte y Europa con altas intensidades de manejo forestal por unidad de superficie a excepción de la EX-URSS, permite explicar la importancia de la actividad forestal en estos países que en conjunto abarcan el 39 % de la superficie arbolada en el mundo y aportan el 44.3 % a los 3,000 millones de m^3 de madera producidos anualmente, basando su economía en esta actividad en un 5 % o más.

De acuerdo con lo señalado, es notoria la importancia del manejo forestal y de la investigación como fuente de obtención de conocimientos, para un aprovechamiento integral y racional de los recursos forestales y obtención de beneficios económicos para el desarrollo de los países con recursos forestales suficientes.

En base a esto último, el objetivo del presente documento es el presentar las caracteristicas del manejo forestal, la investigación forestal realizada, sus tendencias, perspectivas y su relación con la sostenibilidad forestal para la zona templado-fría de los Estados Unidos Mexicanos.

LA ACTIVIDAD FORESTAL EN MEXICO

La superficie arbolada de bosques de clima templado-frío de México es de 25.5 millones de ha, de las cuales son bosques de coníferas y latifoliadas 17.0 millones de hectáreas y 8.5 millones de hectáreas de latifolidas. De esta superficie arbolada de bosques de clima templado-frío se encuentran bajo planes de manejo forestal aproximadamente un 36 % (SARH-SFF, 1992).

La producción nacional anual maderable es del orden de los 8.12 millones de m3, compuesta en un 95 % de madera de especies de clima templado-frío (84.0 % del género Pinus, 2.8 % de Abies, 1 % de otras coníferas, 5.0 % del género Quercus, y 2.2 % de otras latifoliadas (INEGI, 1991).

Los principales productos obtenidos son: de escuadría en un 67.5 % de la producción total (incluye tablas, tablones, madera para envase y embalaje, labrados, madera para chapas y tableros y otros productos en rollo), celulosa 24.0 % y combustible con 5.7 %, además de durmientes, postes, pilotes y morillos con 2.8 % (INEGI, 1991).

La industria forestal nacional esta integrada por 2,416 plantas industriales que comprenden 954 aserraderos, 1027 fábricas de cajas, 155 aserraderos con fábrica de cajas, 21 plantas de impregnación, 67 fábricas de tableros, 8 de celulosa, 10 de papel y celulosa, 52 fábricas de papel, 18

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resineras, 106 talleres de secundarios, industria que proporciona empleo a aproximadamente 110,000 personas (CNIF, 1990).

Los bosques de clima templado-frío de México, estan formados por masas puras de una sola especie, masas mezcladas de coníferas y latifoliadas, masas de latifoliadas.

La distribución de los bosques en las diferentes cordilleras del país varia de altitudes de 800-3,300 m sobre el nivel del mar.

México es un país con una gran cantidad de germoplasma de coníferas, principalmente del género *Pinus.* De acuerdo con Martínez (1948), existen 39 especies, 18 variedades y 9 formas, las cuales han incrementado como un resultado de la investigación. Otros géneros importantes de este tipo de bosques son: *Abies, Cupressus, Taxodium*, y *Pseudotsuga*. Los géneros principales de latifoliadas son: *Quercus, Arbutus* y *Alnus.*

Los principales estados mexicanos con bosques de clima templado-frío son: Chihuahua, Durango, Michoacán, Jalisco, Guerrero, Oaxaca, México, Puebla e Hidalgo.

La cantidad total estimada de volumen en pie de estos bosques es de 1,773 millones de m^3, con un incremento anual estimado en 27.5 millones de m^3.

EL MANEJO FORESTAL EN MEXICO

Para poder analizar el desarrollo del manejo forestal en México, es necesario remarcar algunas de las características de sus antecedentes, en lo que se refiere a la utilización de los recursos forestales por las generaciones anteriores que constituyen el legado cultural del país y de ello derivar las proyecciones de hacia donde se debe encaminar el cultivo y aprovechamiento de los mismos. La historia de México marca diferentes etapas de desarrollo que con sus ventajas y desventajas conducen a México a tener sus caracteristicas actuales, tales etapas pueden ser agrupadas a grandes rubros en:

a) Epoca Prehispánica. Los antecedentes históricos obtenidos actualmente de las culturas indígenas que habitaban el país, indican que los usos principales del recurso forestal eran la obtención de madera para la construcción, para leña combustible, para armas, para obtención de productos medicinales, recolección de frutos y productos derivados de la fauna.

Una característica sobresaliente de la mayoría de las comunidades indígenas fue su tendencia a tratar de lograr un balance adecuado entre el uso del recurso forestal y su recuperación, dadas las bases religiosas en que se basaron tales culturas, y por la gran diversidad de necesidades que satisfacían mediante la utilización correcta del recurso forestal.

Las principales culturas indígenas que se desarrollaron en la zona templado-fría de México fueron la Chichimeca, la cual se asento en la Sierra Nevada del centro del país, en áreas cubiertas por bosques de coníferas basando su forma de vida principalmente en la cacería. De esta cultura resalta el gobierno del Rey netzahualcoyotl quien durante su mandato creó nuevos jardines y bosques, algunos de los cuales aún persisten como el de Chapultepec. Este Rey tuvó un gran interés conservacionista de los recursos naturales y dictaminó leyes que regían su aprovechamiento.

Otro grupo importante lo fueron los Purepechas quienes habitaron a las orillas del Lago de patzcuaro y que abarcaron los estados actuales de Michoacán, Guanajuato, Querétaro, Guerrero, Colima, Jalisco y Nayarit (Moncayo, 1981). Esta cultura utilizó el recurso para leña para actividades religiosas, y le dió mayor importancia a la cacería, agricultura y pesca.

La cultura Azteca, asentada en el valle del Anáhuac, se caracterizó por conquistar otras culturas, ampliando su territorio el cual consistía de abundantes áreas arboladas. En sus actividades destaca la agricultura, realizada mediante la tala de la vegetación, la quema del área desmontada y siembra en época de lluvias. Asi mismo, realizaban un ciclo de descanso del suelo, hasta que se cubría de vegetación y después se volvía a repetir el ciclo. Su principal característica con respecto a los recursos forestales fué la protección de sus bosques para poder abastecerse de madera, para la satisfacción de sus necesidades en la construcción de edificios, canoas, y obtención de leña y carbón (Moncayo, 1981).

b) Epoca Colonial. Después de la llegada de los Españoles a la Nueva España y una vez concluída la conquista, conforme avanzó el asentamiento Español, se causó una fuerte disminución de los recursos forestales, causándose a la vez el empobrecimiento de los suelos. Esto se debió al gran número de explotaciones mineras, que requirieron de productos de los bosques para la obtención de pilotes, leña y carbón para los hornos de laboreo y beneficio de minerales. Además con la expansión de las actividades económicas, la agricultura cambio de intensiva durante la época indígena a extensiva, por lo que se desmontaron grandes superficies, sucediendo de igual manera con la introducción de la ganadería (Moncayo, 1981).

c) Epoca Independiente. En el México independiente dadas las condiciones política, social y económica originadas durante la colonia, se agudizaron de tal forma que el país se encontraba en un estado anárquico, lo cual causó un gran atraso en las actividades

económicas y productivas de la nación, reduciéndose a actividades del autoconsumo (Moncayo, 1981).

En referencia al uso de los bosques durante esta época, destaca la fuerte explotación de las regiones selváticas en los estados de Tabasco, Campeche, Yucatán y Oaxaca para el comercio exterior. Este tipo de explotaciones sin ningún criterio técnico y una marcada sobreexplotacion causó, también una fuerte destrucción de los recursos forestales de esas regiones.

Con la contínua estabilización de las condiciones políticas, económicas y sociales después de la lucha de independencia y durante los inicios de la República, el aprovechamiento del recurso forestal se inició con la idea que su cuantía era innagotable, para lo cual se llevó a cabo una promoción para la inversión extranjera en el país, dando como consecuencia la construcción de vías férreas para facilitar la extracción tanto de recursos minerales y maderables del país (Moncayo, 1981).

d) Epoca Actual. Es así como a inicios del presente siglo que al tenerse una época de restablecimiento y organización comenzaron a tenerse algunos avances en la explotación de los bosques mexicanos.

Esta etapa histórica de México en el manejo de sus bosques se caracteriza por tener varias etapas bien definidas por las características de los avances tecnológicos empleados en el cultivo y aprovechamiento de los bosques.

1. Inicios del siglo XX hasta 1940. Los antecedentes de la incipiente silvicultura en México se localizan en el estado de Chihuahua, de acuerdo con Moncayo (1981), estas intervenciones tuvieron su origen en 1896, al inaugurarse la construcción de líneas férreas de la compañía del ferrocarril "Rio Grande-Sierra Madre y Pacífico". A principios del presente siglo no se conocía la cantidad de las extracciones de madera, pero debido a la iniciación de la comunicación por ferrocarril se promovió el interés en llevar algún tipo de control de los aprovechamientos, así para 1905 la producción de los aserraderos instalados se calculaba en 7.6 millones de pies cúbicos.

Lo anterior dió pauta al uso generalizado de métodos basicamente europeos para el cultivo y manejo de los bosques del país, lo cual fué el resultado de la llegada a México de Profesionistas Forestales Franceses en 1909.

Los métodos de manejo utilizados durante ese tiempo fueron: el de Cabida, Von Mantell, Heyer, Suizo y Francés, todos ellos derivados de bosques regulares ó irregulares sensiblemente normalizados en los que la edad es un parámetro ordenador (Rodríguez, 1960).

2. Etapa de 1940 a 1980. Moncayo (1981) señala que la aplicación de métodos europeos concluyó en 1943, debido a que por las características naturales de los bosques naturales de coníferas no se cumplía con las metas previstas por esos métodos de manejo.

En 1944 con la circular del 9 de octubre se estableció la utilización del incremento corriente anual en volumen como factor de productividad maderable. Con lo anterior se marcó la pauta para la generación de nuevas ideas para el aprovechamiento de los bosques del país. De esta manera, se originó el Método Mexicano de Ordenación de Montes (MMOM) en 1960, que se basa en la extracción selectiva de arbolado sobremaduro a través de cortas selectivas, que dieron origen a bosques irregulares (Moncayo, 1981).

El Método Mexicano de Ordenación de Montes, se aplica basado en el cómputo de una posibilidad anual de aprovechamiento en función de los volúmenes existentes por ha y el incremento corriente anual (m^3/ha/año), y la definición de una intensidad de corta por unidad de superficie, para finalmente determinar el ciclo de corta, que se considera el tiempo necesario para alcanzar a recuperar el volumen extraído. Este método se caracteriza por el uso del sistema de tratamiento silvícola de selección con la limitante de aplicarse a un diámetro mínimo de corta. Mediante este método en el país se aprovechan anualmente 7,450.908 (m^3r) que corresponden a un 78.8% de la producción nacional anual (Cuadro 1).

Cuadro 1. Volumen extraído en México durante 1984 (m^3r).

GENERO	MMOM *	MDS **	TOTAL
Pinus	6,030,396	1,689,428	7,719,824
Abies	302,436	51,992	354,428
Otras coníferas	63,451	6,653	70,104
Quercus	300,744	236,397	537,141
Otras hojosas	164,875	13,149	178,018
Preciosas	116,855		116,855
Corrientes tropicales	457,827		457,827
Otras	14,324		14,324
TOTAL	7,450,908	1,997,619	9,448,527

* *Fuente: Memoria económica de la Cámara Nacional de las Industrias Derivadas de la Silvicultura. México.*
** *Fuente: Subsecretaría de Desarrollo y Fomento Agropecuario y Forestal- Dirección General de Normatividad Forestal-Dirección de Manejo y Abastecimiento Forestal. 1987.*

En forma paralela y posterior se han utilizado otras alternativas al manejo de bosques del país; en 1959 se aplicó el método de fajas alternas para aprovechamientos de sujetos maduros y sobremaduros, previendo una silvicultura más intensiva. Carrillo (1955) propuso la ordenación de bosques de coníferas presentando un sistema de manejo establecido en la Unidad Industrial de Explotación Forestal Loreto y Peña Pobre, similar a métodos europeos de regulación por volumen en base a proporciones de arbolado en diversos estados de desarrollo (Mendoza, 1983). En 1971 Carreón publica resultados de aplicar el Método de Control en el estado de Jalisco, en este método, la Silvicultura que se aplica es en base a selección.

Durante 1973 se propuso el Plan de Mejoramiento Silvícola que da nombre al Método de Manejo Forestal de Desarrollo Silvícola (MDS), que a la fecha es el otro método oficial de aprovechamiento forestal y que se considera como única opción real intentada en México después del MMOM. En este método la meta es la obtención de un bosque normal, contemplando una intensidad de manejo y una producción maderable máxima, sostenida y permanente.

El MDS es una sistematización de técnicas dasonómicas para el aprovechamiento de bosques de clima templado y frío, cuyos objetivos son el captar al máximo el potencial productivo del suelo para la producción de madera y obtener un rendimiento sostenido en volumen y productos, los cuales se pretenden alcanzar a través del concepto de bosque normal.

Se basa en el sistema silvícola de bosque regular con el método de tratamiento de árboles padres, y la regulación de las cortas se realiza a través de área considerando la capacidad productiva del suelo, con la alternativa de hacerlo por área-volumen.

En el horizonte de planeación en el corto plazo, considerando en términos de un año, se contempla la elaboración del plan anual de cortas, que sumados para los años del ciclo de corta dan la planeación a mediano plazo.

El largo plazo es previsto a nivel más general en el proceso de regularización de superficies, se define la secuencia de los tratamientos por aplicar en cada área durante el turno.

Dentro del MDS las divisiones dasocráticas utilizadas son: predio, serie, rodal, subrodal, parcela de corta y área de corta.

El predio (o grupo de predios) es una unidad de manejo para la cual se plantéa el objetivo de rendimiento sostenido; la serie y el rodal se utilizan para agrupar áreas equiproductivas; el subrodal para detectar la condición actual dada por las características dinámicas del bosque.

Con el método se busca la ordenación del bosque a través del concepto de Bosque Normal-Regular, y aplicar los tratamientos silvícolas fijados por el método de tratamiento de árboles padres, en base a el turno, el ciclo de corta y los tratamientos silvícolas por aplicar. Bajo este método en México se aprovechan 1,997,619 m^3 que corresponden al 21.2 % de la producción nacional.

Desde el punto de vista de tratamientos silvícolas el MDS aporta un beneficio en este campo al incluir el uso de tratamientos como el de árboles padres, que es el que mayormente se ha aplicado en el país, y que se adecúa en muchos casos a la ecología de las especies, por lo que es claro que de 1973 a la fecha se le ha dado gran importancia a la silvicultura, lo que sin duda redundará en el mejor conocimento del manejo forestal (Manzanilla, 1987).

De acuerdo con estimaciones realizadas, la superficie bajo manejo en el país con los dos métodos es en proporción 7:2 (7 millones/ha; MMOM 2 millones/ha; MDS), lo que proporciona una idea de la tendencia de la silvicultura y en manejo forestal que se ha estado aplicando en México.

De acuerdo a los antecedentes anteriores, es posible observar que la silvicultura en México ha mantenido un carácter proteccionista debido principalmente al desconocimiento de la flexibilidad de las especies a otros tratamientos, y desconocimiento de métodos de manejo, resultando en que los aplicados actualmente no se han alejado mucho de las corrientes de manejo forestal dominantes en los años cuarentas (Mendoza, 1983).

3. Etapa 1980-Actual. A partir de 1986 con la nueva Ley Forestal surge el concepto de Manejo Integral Forestal, el que complementado por las disposiciones derivadas de la nueva Ley General de Equilibrio Ecológico y Protección al Ambiente, proporcionan un nuevo marco legal a los aprovechamientos forestales (SFF, 1992).

Conceptualmente el Manejo Integral Forestal se define como "La administración de los recursos forestales tendiente a obtener el rendimiento óptimo persistente de algún(os) bien(es) y servicio(s), minimizando el deterioro de estos y de sus asociados" (SFF, 1992).

En el caso de que la producción maderable sea uno de los usos principales definidos, los estudios de manejo integral forestal, serán planes para producir madera sin limitar en el mismo la producción de otros bienes y servicios de acuerdo a un entorno (SFF, 1992).

Actualmente se utiliza para planificar dichos estudios de manejo integral forestal, el Sistema de Conservación y Desarrollo Silvícola (SICODESI), que se ha desarrollado dentro del Acuerdo de Cooperación Científica y Técnica en el Sector Forestal entre México y Finlandia (SFF, 1992). Este Sistema (SICODESI), en su estructura general para la planificación del Manejo Integral Forestal consiste de dos niveles de planeación:

1. Planificación Estratégica. En esta se evaluan las interacciones entre el sector forestal, los propietarios y otras actividades económicas, y por otro lado, entre las actividades forestales y el ecosistema. Analizando la situación actual y

estimando los cambios futuros, se elabora un plan de producción forestal a largo plazo con un horizonte de 30 años. Este plan es utilizado en los estudios operativos como un objetivo en cuanto al nivel de producción (SFF, 1992).

Los resultados esperados de los estudios estratégicos son: la caracterización de los recursos forestales y el mercado de sus productos, tanto actuales como potenciales; la identificación de la legislación aplicable y de aspectos relevantes de la opinión pública; la determinación de las principales interacciones entre los diferentes recursos y el maderable; la proyección de la situación actual al futuro y la determinación del nivel adecuado de producción maderable en base a las interacciones y proyecciones estudiadas (SFF, 1992).

2. Planeación Operativa. Se describen las acciones necesarias para lograr el objetivo de la planeación estratégica. Los resultados esperados son: la ubicación de las actividades forestales recomendadas a corto plazo; la determinación precisa de la cantidad de madera por cortar; la estimación y recursos requeridos, tanto humanos como de maquinaria y equipo; y la estimación de los costos y beneficios esperados.

El sistema esta diseñado para ser utilizado en bosques de coníferas. Una de sus caracteristicas relevantes, es que se establecen las bases para que los planes se vayan mejorando cuando se repita el proceso de planeación estratégica al término del primer período. Durante el período estratégico, 10 por ciento de los sitios de muestreo se establecen como permanentes, formando una red de monitoreo y control en base a su remedición futura. La información de estos sitios es útil para mejorar los modelos utilizados y también para actualizar el plan (SFF, 1992).

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A Decision Support System for Integrated Forest Management for the "San Juan Tetla" Experimental Forest

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ABSTRACT — This paper presents a multidiciplinary effort to build a Decision Support System (DSS) for integrated forest management in Mexico. First the philosophy of design, maintenance and development is presented. Later, the ideal DSS to strive for is depicted. Finally, the advances in the development of the SIMBAT DSS for the "San Juan Tetla" experimental forest are described. It is concluded that a DSS provides an excellent vehicle for the direction, testing and integration of research efforts in integrated forest management.

INTRODUCTION

The requirements for data gathering, manipulation and collation in the forest management activity have increased as a function of three main factors (Buhyoff et. al., 1988): 1) increased requirements, legislative and otherwise, to assess the interrelationships and production capabilities of multiple resource bases; 2) increased capability and accessibility of computer and other automated data-processing technologies; and 3) increased numbers and sophistication of mathematical prediction systems.

In Mexico new laws make mandatory the consideration and management of associated resources in forest management plans. Unfortunately, there is little information of joint production functions, responses to management prescriptions and lack of professionals sensitivity for the implications of their management decisions. Furthermore, as new variables are included in the management problem, it becomes increasingly complicated and difficult to solve, analyze and implement.

These factors make necessary a tool that would allow rapid formulation, solution, analysis and presentation of results of integrated forest management plans. This tool should also be an education medium for managers and management scientists. A Decision Support System (DSS) would be such a tool.

This paper presents an interdisciplinary effort to create a DSS for integrated forest management in the "San Juan Tetla" experimental forest. First, the philosophy of design, maintenance and development, and use is presented. Here the aim is to present the ideal to strive for. Second, the characteristics of each of the modules of this ideal system are described. At the same time, the advances in Mexico on each of the modules are presented. Finally, the current advances on the development of the "San Juan Tetla" DSS are presented.

LITERATURE REVIEW

A Decision Support System (DSS) functions to bring data, models, software interfaces, and the user together into an effective decision-making system. Such systems integrate the computer into the decision making process so that the computer is an integral part of decision making and planning, and thus allows managers to "use" information rather than simply be recipients of it.

A DSS is an interactive computer-based information system designed to aid managers in the decision making process (Oezdemirel, 1987; Vazsonyi, 1982 and Alter, 1977). Armstrong (1986) identifies four key modules in the architecture of a Spatial Decision Support System (SDSS): 1) A Database Management System (DBMS), 2) analytical models, 3) graphical display and report generators and 4) a user interface. Densham and Goodchild (1989) point to the

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issues that need further research in the area of SDSS's. These authors point out that modularity of the SDSS facilitates the programmer's work but to the user the system should appear to be a seamless entity.

Donovan (1976) describes the characteristics of problems to be solved through the use of a DSS as follows: 1) the problem is continuously changing, 2) the answer are needed quickly, 3) data are continuously changing and come form a variety of sources, 4) data must be processed into different kinds of data representations, and 5) when computer support is required, one is more concerned with rapid implementation than long-term efficiency.

Mahmood and Medewitz (1985) as part of their evaluation on the relation between design method and DSS success, point out that, according to the literature, there are basically three DSS design methods: 1) Carlson (1979, 1982) representation-based, 2) Courbon (1978, 1980) evolutive, and 3) Keen (1980) adaptative. In their limited study they concluded that: "overall, the findings favored the evolutive method over the other two".

Courbon et. al. (1978) suggested the evolutive approach as "a methodology based on progressive design of a DSS, going through multiple as-short-as possible cycles, in which successive versions of the system under consideration are utilized by the end-user". The evolutive method is based on four steps: a) identify an important subproblem; b) quickly develop a small but usable system to assist the decision maker; c) refine, expand, and modify the system; and d) evaluate the system constantly.

Guiaseddin (1986) points that since the problem space of a DSS and the user's conception and/or perception of the problem is continually changing, the DSS should be produced rather quickly. Otherwise, it will be obsolete as soon as the development process is finished. He mentions that the key to the development of a successful system is the correct understanding of the problem by the developer. Errors in the requirements specification are usually the last to be detected and the most costly to correct (Boehm, 1978; Gomaa and Scott, 1981). Also, many users, especially the DSS users, do not have a clear understanding of their true needs prior to actual utilization of the system. With a prototype the user can more accurately examine whether the right problem is being solved and also if he/she has been understood correctly by the developer. The emphasis in prototyping should not be in producing a very efficient system; rather the emphasis should be on rapid production of a prototype which accurately reflects the requirements of the proposed system in the manner perceived by the developer.

The same author suggests a scheme to maintain communication and coordination among developing teams (fig. 1). In it, each module of the DSS is a project composed of subsystems and these in turn by components.

OBJECTIVES

Integrated forest management implies a changing environment, with a need for quick responses, with changing data coming from a variety of sources and with a need for strong computer support. These characteristics made it suitable for the application of DSS.

This project has the following objectives:

1. Design a Decision Support System that would allow to integrate models to support integrated management in the "San Juan Tetla" Experimental Forest.

2. Define simple, practical, economic and effective ways to integrate successful DSS for integrated forest management.

3. Identify research priorities for the integration of DSS.

THE DECISION SUPPORT SYSTEM

The proposed DSS considers the integration of four basic modules: production simulators, problem generator, analytic tools and a geographic information system. Figure 2 shows the relationships among modules and how they relate to the common data base and interface.

Following the ideas presented by Ghiaseddin (1986), each module in the system constitutes a project. Each project is composed of subsystems, and these in turn, by components. The system must be as modular as possible, for this each component must perform one and only one function.

To facilitate the integration and maintenance of the system, all components must communicate on a common language. Given that most input/output is in terms of data files, it is proposed that a dBase look-alike programming language be used. Data files would be read and written in dBase format into a common database. This characteristic will allow for:

a) Existance of each module in its most efficient form. New modules can be written in any language.
b) Productivity gains by using existing modules.
c) Flexibility to add and remove modules.

Critical parameters in the different modules would be written to the common database with an identifier. This will allow later selective retrieval for sensitivity, parametric and knowledge-base models analysis.

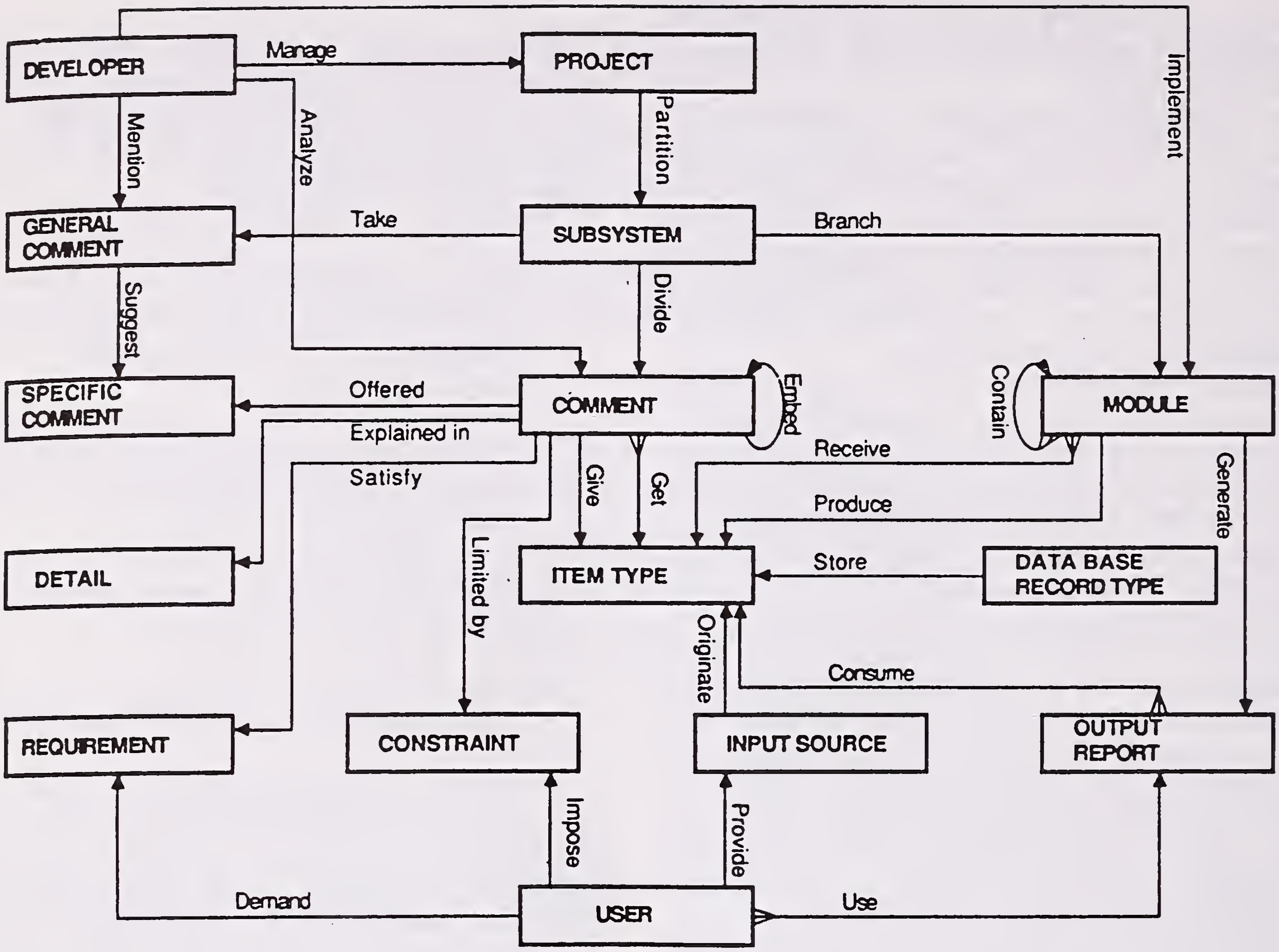

Figure 1. — Diagram to keep coordination and communication in the DSS development process. (Source: Ghiaseddin, 1966)

The system's interface will strive to have the following characteristics (Brennan and Elam, 1986):

a) Presents results in form and terms the user is familiar with.
b) Explanatory capabilities. This is, it will answer to "why did it happen?" and not just "what happens if?" questions.
c) Guidance capabilities. It will address the question "what to do next". It will provide clues as to interesting or important changes to model structure or parameters. Also, it will help to recognize opportunities and pitfalls.

For the maintenance and development of the system, the evolutive approach as explained by Courbon et. al. (1978) will be followed. For the creation of each module a working team was formed that included people versed in both the technical and computational aspects of the task. For communication and coordination among development teams the framework suggested by Guiaseddin (1986) will be used (fig. 1).

The modules, subsystems and components have been conceived so that they follow the philosophy of design, maintenance and development above described. The modules, their characteristics, use, likely developments, as well as current advances in Mexico are described next.

PRODUCTION SIMULATORS

This module has been divided in three subsystems:

1. Growth and yield models and simulators. INIFAP has developed three whole stand yield models for the following species *Pinus hartweggii, P. rudis* y *P. montezumae*. Currently, a growth and yield simulator for *Pinus cooperi* and *P. engelmannii* based on individual tree models is being developed.

Additionally, support systems and methodological principles are developed to feed the growth and yield simulators. Important contributions are: computer systems to develop stem analysis and inventory data processing; computer systems for special data analysis such as:

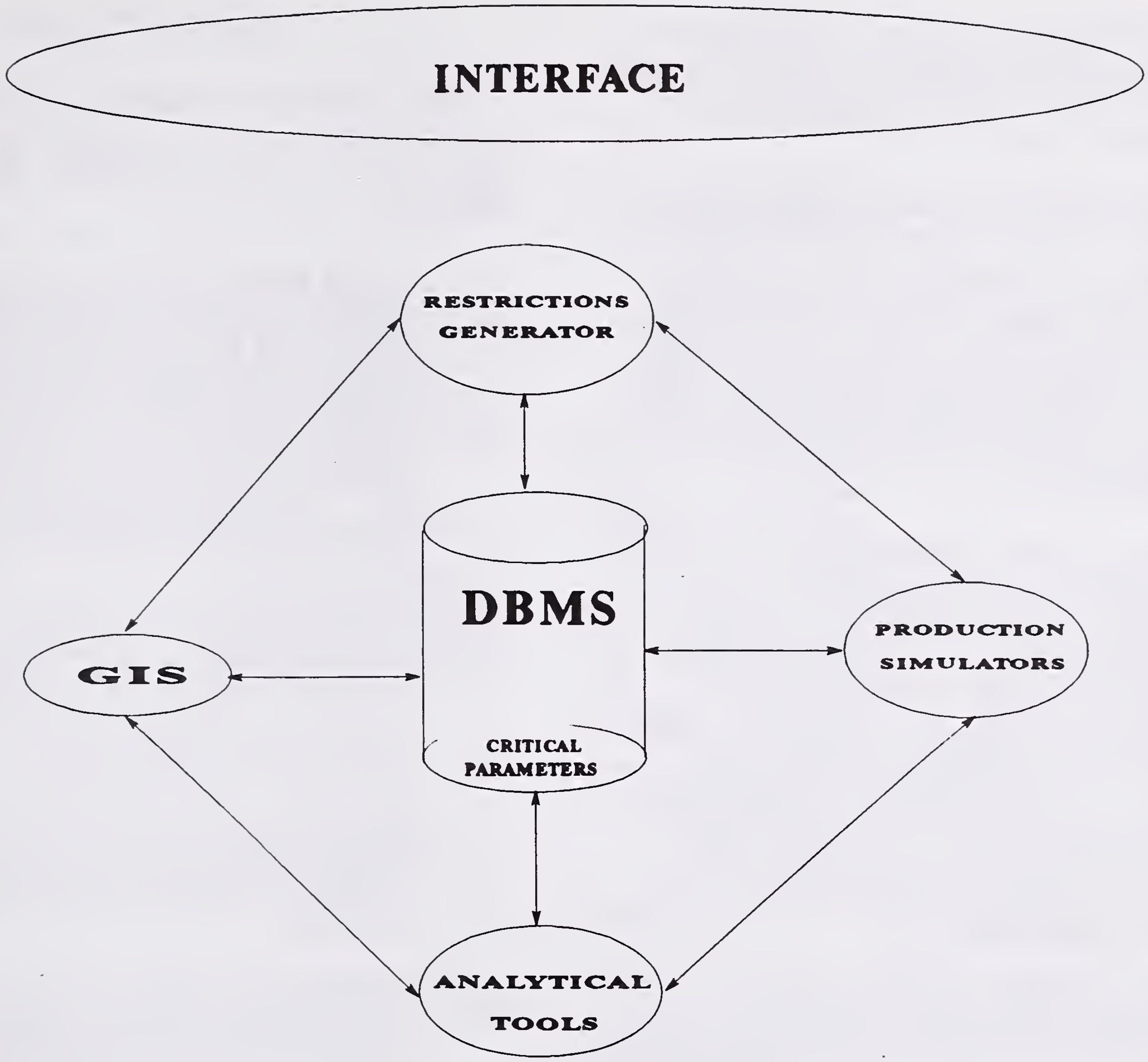

Figure 2. — Modules that form the proposed DSS.

estimation of "robust" estimators for the Weibull distribution; techniques to improve estimations of diameter distributions, taper functions and compatible growth models; development of new procedures to measure stand density and site index for mixed and uneven-aged stands, with application to real natural forests conditions and tropical forests.

2. Yield of associated resources: In this subsystem efforts are made to estimate production functions of different associated resources. Current developments include the yield estimation of mushroom and several grasses growing under different stand conditions.

3. Price and cost simulator: This subsystem integrates trends in market elements such as real prices, demand, supply, exports, imports supplementary products, production costs and harvesting costs, among others. Current developments include the integration of historical data on production and harvesting costs, prices and production for most of the wood-based forest products, mushroom, and several comestible plants, as well as estimation of market demands and supplies for pulpwood, sawlogs and sawnwood by premium. As part of this area of study, computer systems to perform financial analysis, cost analysis and information systems have also been developed.

PROBLEM GENERATOR

This module integrates all subsystems needed for multiple use, production externalities and economic constraints required in the management of resources. It has been divided in 5 subsystems:

1. Resource economics. Integrates studies on valuation of forest resources without a market structure to include such alternatives of production into the management plans as objective not as constraint of production.

Developments on this area include estimations of recreation demands in the Valley of Mexico and valuation of wildlife for medicinal and comestible uses.

2. Socioeconomic. Considers studies related to estimate effects of inhabitants of the forests related its development, such as fuel needs, comestibles (flora and fauna), medicinal and surrounding industry needs, as well as trends of deforestation, change of land use and other human made disturbances in the forests. These estimates are used to form management constraints.

3. Forest Protection. Includes basic studies on fire, ecology of pests and diseases, as well as behavior of other disturbances. Those basic studies are then used to develop risk maps, spread movements and management considerations such as species behavior, stand structure and biodiversity requirements to reduce risk of disturbances. Developments in this area include works in association with other research institutions considering risk maps for different pests and maps of risk of fire for some areas.

4. Land stratification. Integrates studies on stratification of areas for efficient use of land, so that they provide non-traditional alternatives of management, change of species, infrastructure development, and goals of management and conversion to be included in the management plan. Developments include digitalization of 7 variables for most of the forest areas of the country.

5. Applied ecology. Integrates autoecological and sinecological studies to define optimum habitat requirements for different flora and fauna species, as well as indicators of rates of water production, soil conservation, biodiversity indexes for harvest intensity, buffers and riparian zones protection. Developments in this area include definition of ecological conditions for the optimum establishment of some species in the "Selva Baja" (Tropical dried forest), oak associations and habitat requirements for some wildlife species.

ANALYTIC TOOLS

This module integrates the subsystems needed to formulate, solve and present problems of management of forest resources. It has been divided into the following subsystems.

1. Current algorithms and models. This subsystem considers the import and application of analytic tools already available for the formulation and solution of management problems. Some developments in this area include the applications of Lagrangian relaxation to harvest scheduling problems and the use of Dynamic Programming in the optimization of the stand level problem.

2. Design and analysis of algorithms. This subsystem integrates the new developments on design and application of analytic tools to the formulation and solution to the forestry resources management problems to stand and forest levels. These developments consider the use of alternative mathematical programming techniques, heuristics, Multicriteria Decision Making, simulation approaches and stochastic techniques.

3. Knowledge base systems. This subsystem integrates the development of data bases, algorithms and programming structures which provide answers, interpret and guide the solution to improve forest management alternatives. These developments can be made in all the components previously described and are conceived as the special component of the INTERFACE since it will allow for exploration, guidance and explicative capabilities. Some examples already explored are the design of an expert system for forest pest identification and further recommendations of control; an expert system for the selection of species for reforestation; the data base of alternative combinations of mix of species according to ecological requirements in the Central part of Mexico.

4. Modeling languages and methods. This subsystem includes the design of modeling methods, the standardization of modules to develop a library of components, and the integration of modules and data bases for practical applications of the developments.

GEOGRAPHIC INFORMATION SYSTEM

This module will be composed of two subsystems.:

1. Cartographic modeling.

2. Topological support for other modules.

The first subsystem in turn could be divided into the following components: a) Descriptive modeling and b)Prescriptive modeling. The former will include functions such as: Characterization of absolute and relative position, punctual form, lineal form, areal form, and surficial form. The later will be directed to solve holistic allocation problems as conceived by Tomblin (1990).

The second subsystem will allow for: a) formulation of spatial restrictions related to harvesting, conservation of wildlife habitat, roads layout and protection of ecologically sensitive areas; b) graphical display of management alternatives; c) analyses of costs, profits and risks associated with spatial features and/or its layout;

THE DSS FOR FOREST MANAGEMENT IN "SAN JUAN TETLA", PUEBLA OBJECTIVES AND GOALS

The DSS for the "San Juan Tetla Experiment Station" called Sistema Integral de Manejo de Bosques y Análisis Terrestre (SIMBAT) has the following objectives:

a) To be the management support for the Experiment Station.
b) To integrate all the research results conducted in the Station.
c) To integrate the first DSS for forest management support in Mexico, which considers state-of-the-art analytic tools and cartographic support.

The goal of the project is to have integrated the DSS by December, 1993.

DESCRIPTION OF THE SIMBAT SYSTEM

The subsystems of this DSS are integrated according to the philosophy above described. Figure 3 shows a flow diagram of the modules of the DSS and its relationships, as well as the possibilities to access the information being generated at each stage.

SIMBAT is organized such that the decision making process can be divided in different stages. Moreover, such a process considers long run and short term concerns, so that many additional management alternatives can be generated and tested. The system is also organized in such a way that the user has access to all the modules to follow the decision making process, and the possibility to have feed back over the solution attained at a given stage.

A special feature of the flow of information in the system is the possibility to analyze the stand level alternatives and fix or test different constraints to this level, before the forest level alternatives and constraints are fixed. In addition, the system allows to revise the last solution, check if constraints meet the desirable requirements and perform additional new formulations before reaching a sensitivity analysis.

GIS capabilities are further extended in the system since it is used to formulate automatically spatial constraints such as adjacency and corridors. It is also integrated to the tactical planning analytic engine to perform spatial modeling,

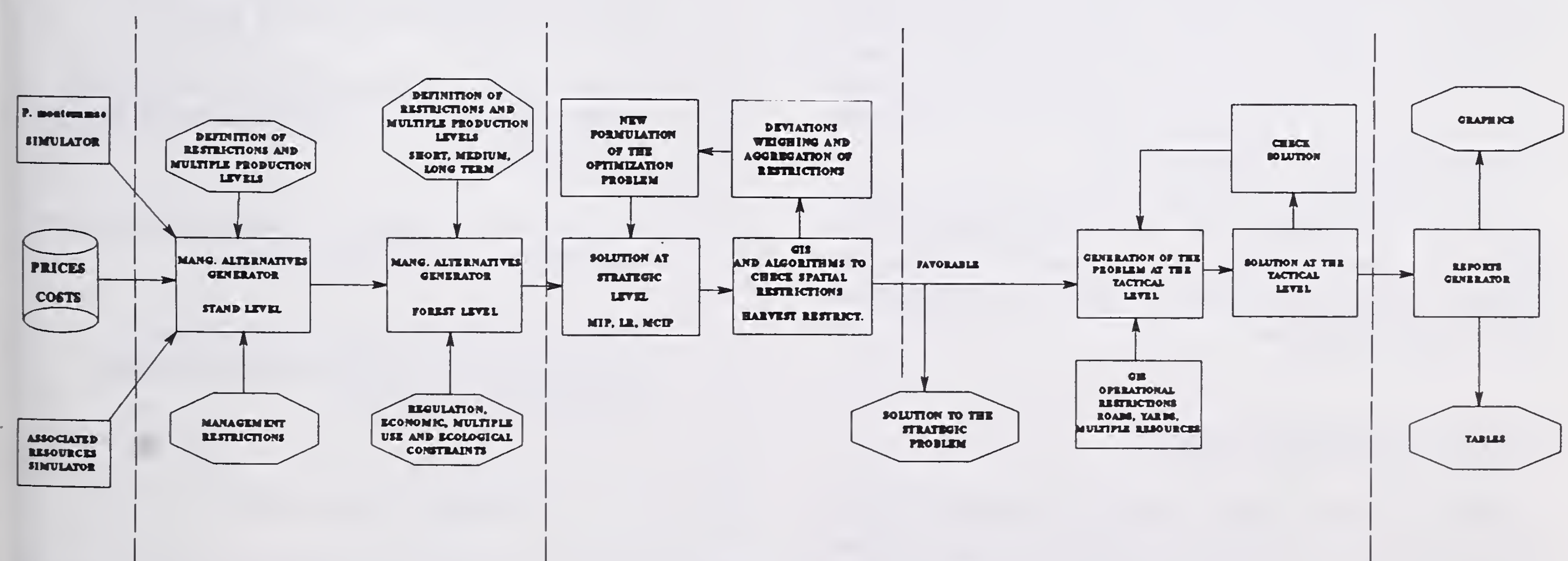

Figure 3. — Flow diagram of the modules of the DDS.

network analysis and friction surface analyses to expand the tactical information and to improve the quality of solutions to operational level.

It is also desirable that the output can be expressed in different forms so that the operative staff has no difficulties to interpret the management recommendations as they are usually expressed and with additional detailed information.

The system has some special features different from most DSS of similar application world wide available:

a) Integrates GIS technology to improve visualization skills, and to reduce direct user's codification of spatial concerns.
b) The strategy to define and select management alternatives considers long and short term concerns of multiple resources, as well as estimation and integration of socioeconomic, industrial and ecological implications of management alternatives.
c) Applies modern technology of operations research to solve problems with spatial concerns.
d) It allows interactive feed-back of the user at each stage.

ADVANCES

The system was conceived in fall 1991 to be developed in two years. Current advances per module are as follows:

1. Production Project.

For this special project a growth and yield simulator for *Pinus montezumae* has been developed. The model can be classified as a whole stand model. It has been already tested for predictions against a forest inventory where it showed good performance. Growth functions for less important species in the area such as *Abies religiosa, Alnus firmifolia* and *Quercus* spp are being developed.

Market conditions for pulpwood, sawnwood, sawlog, mushrooms, comestibles and grasses have been defined. Additionally some preliminary production functions for mushroom, grasses, water and solids have been estimated for different stand conditions.

2. Problem Generator Project

Advances in this project include the estimation of fuel requirements of the inhabitants of the forest areas, studies on fire behavior and definition of risk zones for fire; ecological studies to define appropriate mix of species and tree distributions to reduce risks of pests and diseases; definition of infrastructure developments (road, recreation and harvesting facilities); land stratification with seven variables; definition of buffer, riparian zones, and areas for alternative management uses; habitat definition for 6 important wildlife species and special flora requirements. The matrix generator has also been developed to include wildlife, flora, sediment production, water quality socioeconomic, industrial and financial constraints.

3. Analytic Tools Project

Developments on this project include the generation of a simulator of "viable" stand level alternatives of management according to a set of user-defined constraints; the programming of algorithms for the solution of large scale area-based problems and the development of translators to use commercial software to solve problems.

4. Geographic Information System Project

All the thematic cartography (soils, topography, vegetation, hydrology, property divisions, population, etc.) has been digitized into ARC/INFO with the databases associated to each theme. The first prescriptive modeling has been carried out for roads layout and wildlife habitat.

CONCLUSIONS

The use of a DSS as the engine to direct the research in integrated forest management provides several advantages:

1. Allows research lines to be directed into an already integrated and practical system.

2. Gives an instantaneous application to research results and allows the use of them in advanced steps of research.

3. Improves substantially the control, administration and planning of research activities.

4. Forces the integration of interdisciplinary working teams and creates the idea of team work among researchers.

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EL PAPEL DE LA ACTIVIDAD FORESTAL PARA LA SOSTENIBILIDAD DE LAS ZONAS ARIDAS

L.J. Maldonado Aguirre[1]

Resumen — Las zonas áridas y semiáridas son coincidentes con una creciente marginación social, que tiene como causa principal la explotación extractiva de los recursos naturales, transformando el ambiente en frágil y poco estable. Los efectos manifestados por esta marginalidad son la disminución de su capacidad productiva, expulsión de la población y dependencia de regiones más desarrolladas. Para lograr la sostenibilidad de estas regiones marginales, la actividad forestal debe jugar un papel clave; sin embargo, el problema para el desarrollo de estas regiones y el mejoramiento del bienestar de las personas que viven en ellas, es de gran magnitud y complejidad; magnitud en términos de la extensa superficie afectada y complejidad en cuanto que el desarrollo no debe disociarse de los factores sociales, ecológicos y económicos; otro de los problemas de las regiones áridas y semiáridas, es que no se puede distinguir fácilmente en ellas categorías a efectos de "usos para una sola finalidad", esta dificultad deriva de dos factores principales; el primero es puramente natural como las condiciones del medio ambiente; el segundo es la dificultad para distinguir las tierras a efectos de la sostenibilidad en un uso único de carácter económico. Por ello, por razones físicas y sociales la estrategia de desarrollo debe encaminarse al control de calidad total, promoviendo la integración horizontal del espacio de la producción con la vertical de los productos obtenidos, su transformación, elaboración y su comercialización a fin de optimizar las inversiones en la búsqueda creciente del bienestar de la población rural de las zonas áridas sin el deterioro de los recursos agua, suelo y biota.

INTRODUCCION

Las zonas áridas y semiáridas del mundo (fuera de las áreas irrigadas) son coincidentes con una creciente marginación social, que tiene como causa principal la explotación irracional de los recursos naturales. Actualmente los pobladores de muchas zonas rurales de las regiones áridas y semiáridas están padeciendo graves problemas a causa del deterioro de su entorno natural; poseen menos tierra fértil para el desarrollo de sus cultivos agrícolas, sus bosques producen menos madera, sus agostaderos se vuelven desiertos, la erosión y las inundaciones dañan sus cultivos; en consecuencia la disminución de la capacidad productiva del suelo, ha ocasionado la expulsión de la población y una marcada dependencia de regiones más desarrolladas, afectando también a los sectores más marginados de las ciudades cercanas.

Para elevar el nivel de vida, propiciar el desarrollo socioeconómico y combatir la desertificación en estas regiones marginadas, la actividad forestal deberá jugar un papel clave en la estrategia de sostenibilidad, por lo que es urgente que se identifiquen los problemas y se señalen las insuficiencias como componentes que han de incluirse en un plan indicativo de acciones para la actividad forestal. En el presente trabajo se recomiendan acciones específicas de los elementos de producción, elaboración y utilización de los

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productos forestales, conservación y restauración de los recursos y lineamientos de políticas, en un marco que pueda orientar el desarrollo futuro de los programas forestales en zonas áridas y semiáridas a nivel global, nacional o regional.

LOS DESIERTOS DEL MUNDO

Basado en la clasificación de Meig's y aportaciones más recientes, la distribución de las zonas áridas y semiáridas en el planeta, es superior a los 64 millones de kilómetros cuadrados, lo que representa el 43% de la superficie continental y al 14% de la superficie total del globo terráqueo. Además se considera un 4% de regiones extremadamente áridas o hiperáridas.

Estos desiertos se ubican geográficamente en cinco grandes regiones:

Región de Africa: En esta región se localiza al norte el Desierto del Sahára; al este el de Somali-Chalbi; al suroeste el Namib y al sur el Kalahari y Karroo. (fig. 1).

Región de Asia: Región formada por los desiertos Gobi, Taklamakan, Turkestan, Thar, Iranie, y el desierto de Arabia (fig. 2).

Región Australiana: Dicha región está formada por el desierto de arenas, Simpson, Sturt y el gran Victoria (fig. 3).

Región de Sudamérica: Corresponde principalmente a una franja que se distribuye al oeste de la Costa Occidental; está formada por el desierto Peruano, el de Atacama en Perú y Chile, el desierto Monte, el desierto de la Patagonia y el nordeste del Brasil (fig. 4).

Región de Norteamérica: Se ubica en los Estados Unidos de Norteamérica y en la República Mexicana; comprende 5 subregiones: el desierto de la gran Cuenca, el de Mojave, el Sonorense, el Chihuahuense y el de Baja California (fig. 5).

En México las regiones con deficiencia pluvial cubren una superficie de 1'058,952 km2 lo que representa el 53.8% de su territorio, correspondiendo el 0.9% a zonas extremadamente áridas; 19.4% a áridas; 24.9% semiáridas y 8.6% a márgenes subhúmedas (fig. 6).

ALCANCE DEL PROBLEMA

Más de la mitad de los países del globo terrestre, tienen una parte, o la totalidad de su territorio en zonas áridas y semiáridas. Las tierras del mundo con precipitaciones variables e irregulares representan un tercio de la superficie terrestre y habitan en ellas un 15% de su población.

Precisamente las tierras áridas y semiáridas, conjuntamente con sus márgenes subhúmedos, cubren una superficie de 45 millones de kilómetros cuadrados; es en esta zona donde se produce la desertificación que pone en peligro el sustento de unos 850 millones de personas.

Por otra parte, el programa de las naciones unidas para el mejoramiento del ambiente (PNUMA) estimó que la desertificación afecta un total de 35 millones de km2 de pastizales y tierras de cultivo del mundo.

Actualmente se reducen cada año a un estado de inutilización completa o casi completa unos 21 millones de ha de tierras. Las proyecciones al año 2000 indican que continuará una pérdida en esta escala, si los países no consideran la aplicación de medidas correctivas.

Esto está ocurriendo ya en los países en desarrollo y se está extendiendo a los países industrializados, algunos de los cuales están experimentando grandes problemas de desertificación en sus propios territorios, sólo en Estados Unidos de Norteamérica se está produciendo una grave desertificación en unos 25 millones de acres, superficie aproximadamente igual a la de sus 13 estados originales.

La nueva conciencia del problema de la desertificación, consiste en el reconocimiento de la universalidad de su impacto y de sus causas, que se extienden mucho más allá de las zonas áridas y semiáridas más inmediatamente afectadas; la desertificación, no tan solo provoca la pérdida de la base de los recursos productivos de una nación, sino también, la pérdida de valiosos recursos genéticos, trastornos en el proceso del reciclaje natural del agua, en aumento del polvo atmosférico, la pérdida de mercados y el trastorno de las economías nacionales.

Se está conciente que este fenómeno es obra del hombre y no es el resultado de un cambio de largo alcance del clima:; los estudios sobre la desertificación señalan a las prácticas impropias de uso del suelo como el instrumento más impactante de la degradación de las tierras, como ejemplos se pueden citar los siguientes:

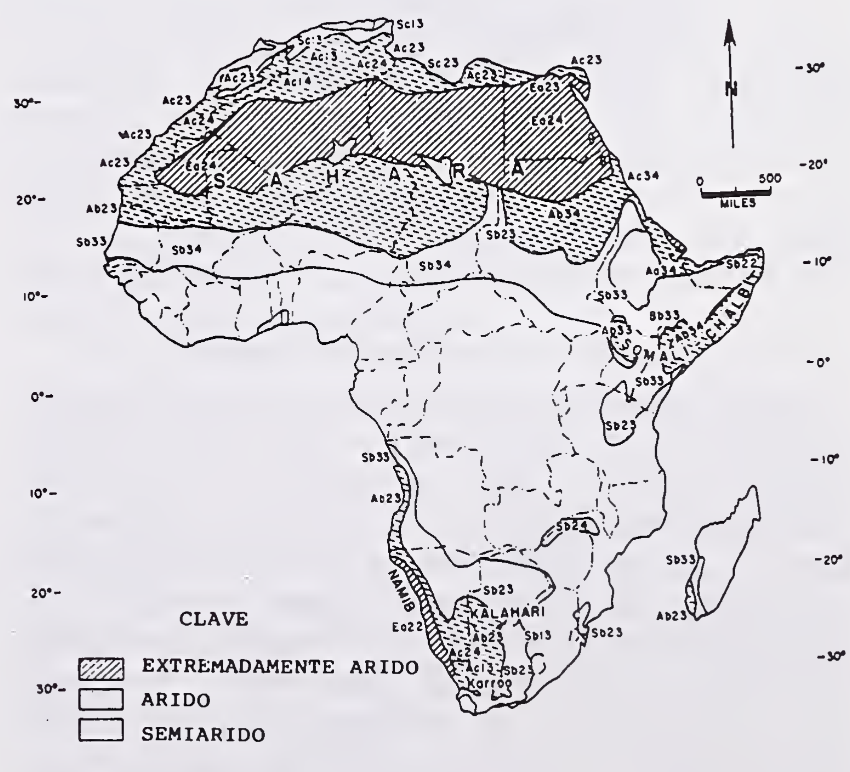


Figura 1. — Zonas aridas de Africa.

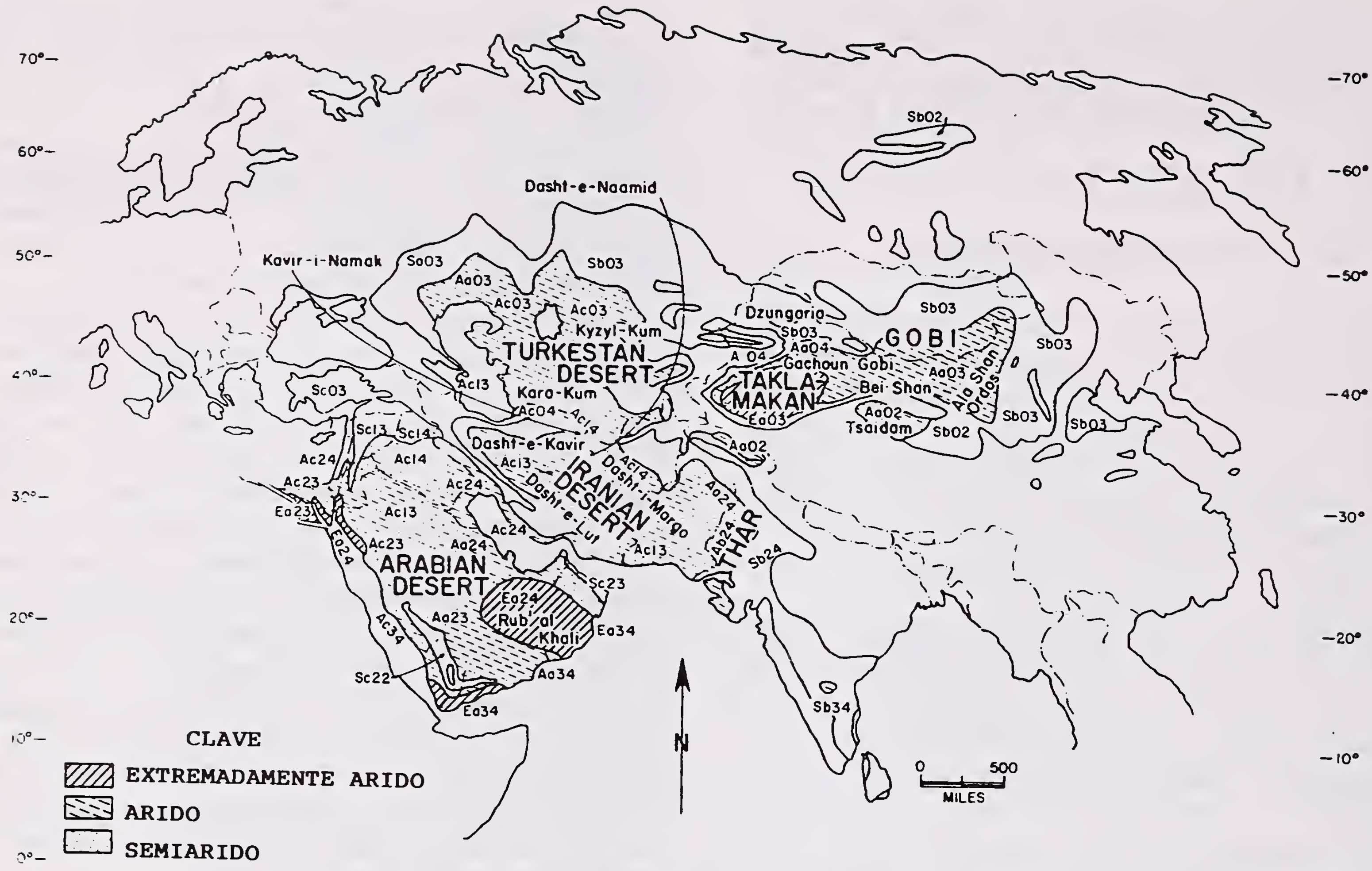


Figura 2. — Zonas aridas de Asia.

Figura 3. — Zonas aridas de Australia.

Figura 4. — Zonas aridas de America del Sur.

En el árido del mediterráneo y en regiones con este tipo de clima, se han roturado grandes extensiones de terrenos forestales para practicar una agricultura sedentaria, ocasionando sobrepastoreo y asentamientos humanos, la destrucción de la vegetación en las cuencas y subcuencas de las montañas, ha perjudicado al régimen de aguas en las laderas bajas, ha provocado en muchos lugares inundaciones catastróficas en los terrenos aguas abajo y el depósito creciente de lodo en los fondos de los valles. Frecuentemente, se producen cárcavas pronunciadas en las laderas cultivadas, sobretodo, cuando por causas de la presión demográfica se ha extendido imprudentemente el cultivo en los suelos de textura ligera, la eliminación de árboles y arbustos ha acelerado en muchos lugares la erosión eólica, se han pérdido para la producción muchas zonas como consecuencia de la invasión de arena o bien por la

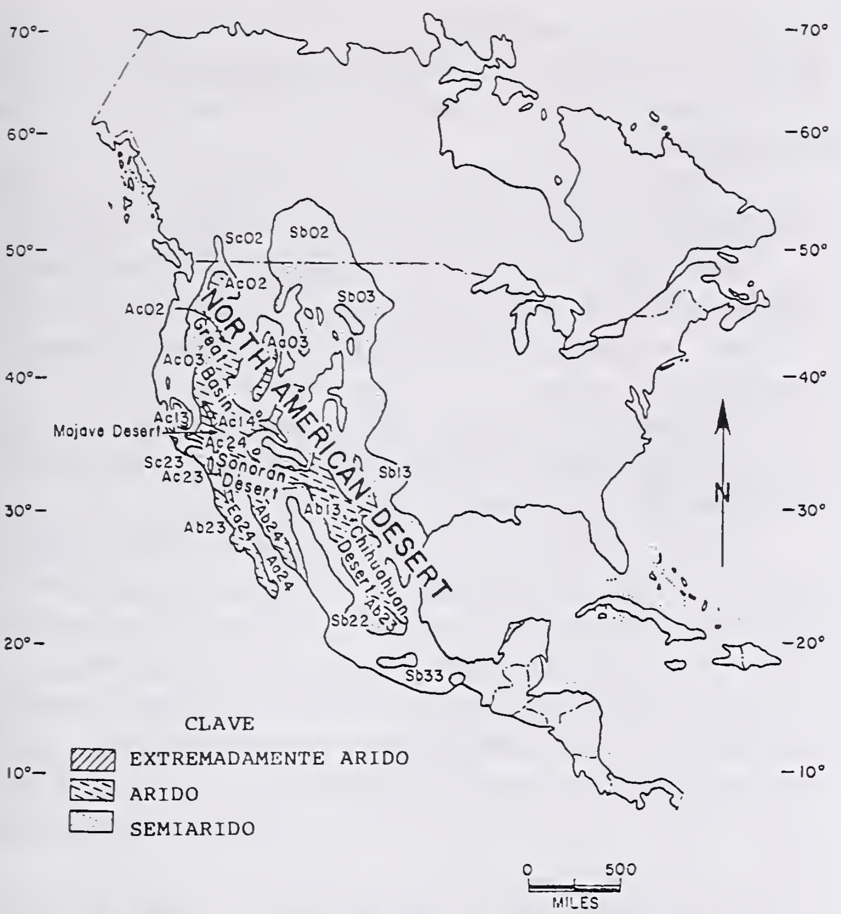
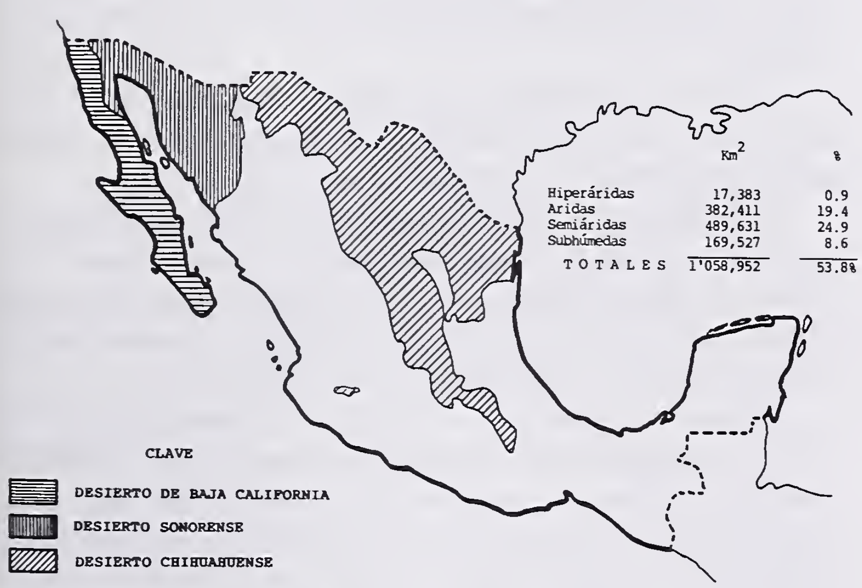


Figura 5. — Zonas aridas de America del Norte.



	Km²	%
Hiperáridas	17,383	0.9
Aridas	382,411	19.4
Semiáridas	489,631	24.9
Subhúmedas	169,527	8.6
TOTALES	1'058,952	53.8%

Figura 6. — Zonas aridas de México (Maldonado 1989).

eliminación de nutrientes y materia orgánica; se ha producido una tendencia análoga en la pérdida de fertilidad del suelo como consecuencia de la agricultura altamente mecanizada en los países en desarrollo y desarrollados en este tipo de clima mediterráneo.

En las zonas tropicales áridas, se suele desmontar las áreas forestales de sabanas abiertas, quemando la vegetación para crear el lecho de siembra, provocando el agotamiento de la fertilidad del suelo, por el consumo de nutrientes y por el deterioro de su estructura.

En los climas árdios continentales, el relieve de los suelos tienen normalmente la forma de llanuras abiertas, caracterizadas por la ausencia de árboles, sus suelos no estructurados y de textura ligera que reposan sobre estratos de induración de carbonatos de calcio, resultan afectados sobre todo por la erosión.

Además de los problemas de fertilidad del suelo y erosión hídrica y eólica se ha agravado cada vez más el problema de la búsqueda de leña para uso doméstico, como un factor importante que se suma a la presión ya fuerte sobre los actuales recursos leñosos.

En Africa, al sur del Sahára, 50 millones de personas, de las zonas áridas, no podían satisfacer sus necesidades mínimas de energía en 1980, pese a que se utilizaba en exceso la vegetación leñosa existente. En las zonas de sabanas, de una densidad demográfica relativamente alta, podían satisfacer sus necesidades mínimas de energía solo recurriendo a un corte excesivo de la vegetación existente.

En el norte de Africa y Medio Oriente, la situación de déficit de leña-combustible, afecta a unos 700 millones de personas distribuidas entre todos los países.

En la región de Asia y el Pacífico, alrededor de 21 millones de km2 de tierra serán afectadas y amenazadas por la desertificación; debido a la deforestación, al cultivo migratorio, la erosión, la aridez, la densidad excesiva de pastoreo, el anegamiento y la salinidad.

La erosión del suelo es una grave amenaza para el ambiente, como resulta claramente del hecho de que en Asia los sedimentos depositados cada año por los ríos totalicen alrededor de 14,500 millones de Mg, lo que representa el 70% del total mundial. La superficie afectada por la salinidad del suelo en la región se cifra en unos 478 millones de ha, siendo Australia, China, India, La República Islámica de Irán y Pakistán donde se plantean los problemas más graves.

En México, se estima que un 66% de la superficie del territorio se encuentra erosionada y de éstas, el 16% muestra un avance crítico de desertificación.

La mitad de las tierras cultivadas se deterioran anualmente a causa de la destrucción de las comunidades vegetales, la prácticas de una agricultura mal planificada y al sobrepastoreo. Se calcula que cerca de 225 mil ha anualmente se desertifican por estas acciones,

Las pérdidas de suelo son de 2.8 Mg ha-1 año-1, lo que representa a nivel nacional una pérdida anual de 560 millones de Mg de suelo fértil.

La sobreutilización de los mantos acuíferos en diversas zonas del país está provocando una creciente salinización de los suelos. La contaminación de las cuencas hidrológicas causadas por las descargas industriales, el uso excesivo de agroquímicos y las aguas residuales urbanas causan daños al medio ambiente en forma considerable.

En el aspecto ecológico los problemas se pueden sintetizar en una pérdida de aproximadamente 12 millones de hectáreas de bosques y 26 millones de hectáreas de selvas, en lo que va del siglo, es decir 19% del territorio nacional.

En las zonas áridas, los aprovechamientos se han dirigido a la extracción del recurso renovable no maderable, en particular la cera de candelilla, las fibras de lechuguilla

y palma samandoca, las cactáceas, la jojoba, el orégano, etc., sin estar acompañada la extracción con la normatividad, asistencia técnica e investigación necesaria, por lo que se extrae lo más fácil cancelando otros usos y posibilidades.

EL PAPEL DE LA ACTIVIDAD FORESTAL PARA LA SOSTENIBILIDAD DE LAS ZONAS ARIDAS

El papel de la actividad forestal en las zonas áridas debe desempeñar una fundamental importancia en la estrategia de desarrollo con base a las siguientes:

Consideraciones Generales

El problema del desarrollo de las tierras áridas y la mejora del bienestar de las personas que viven en ellas es de gran magnitud y complejidad; magnitud en términos de la extensa superficie afectada, y complejidad en cuanto que el desarrollo no puede disociarse de los factores ecológicos, sociales y económicos específicos.

Factores Ecológicos: Uno de los problemas fundamentales del desarrollo de las tierras áridas y semiáridas (aparte de las zonas regadas) es que no se pueden distinguir fácilmente en ellas categorías a efectos de "usos para única finalidad". Esta dificultad deriva de dos causas principales; la primera es puramente natural como las condiciones del medio ambiente. La segunda causa es la dificultad para distinguir las tierras a efectos del desarrollo para un uso único de carácter económico.

Factores Sociales: Las zonas secas están habitadas frecuentemente por poblaciones humanas las cuales, pese a su papel en la economía nacional (ganadería, artesanía, minería), no se les ha hecho participar suficientemente en el desarrollo nacional.

La incorporación de estas poblaciones en el proceso de desarrollo nacional plantea un considerable desafío socioeconómico. Por otra parte, el problema se agudiza a medida que la población sigue creciendo en las zonas de bajas precipitaciones sin que haya el correspondiente aumento de las posibilidades de empleo fuera de la agricultura.

Factores Económicos: La baja productividad de la base de recursos en las zonas secas, unida a la fluctuación en los rendimientos debido a la escasez e irregularidad de las precipitaciones, ha tendido a desalentar la inversión y el desarrollo de insumos científicos para conservar e intensificar la productividad de las zonas con bajas precipitaciones, lo que ha ocasionado un manejo regresivo y una economía anémica subsidiada por el despilfarro de los recursos agua, suelo y biota.

Funciones: Las especies y las actividades forestales tienen funciones importantes que desempeñar en la estrategia de desarrollo de las zonas marginadas, se pueden citar entre otras las siguientes:

Conservación del suelo y agua, protegiendo las cuencas hidrográficas mediante la plantación de árboles dispersos.

Participación en el sistema de producción agrícola por medio de cortinas protectoras y mediante el enriquecimiento del suelo con el uso de especies forestales fijadoras de nitrógeno.

Contribución en la producción ganadera por medio de la creación de reservas de forrajes en forma de arbustos para amortiguar las calamidades provocadas por la sequía.

Producir madera, leña, carbón, goma, resina, fibra y otros productos forestales que son la materia prima para el desarrollo de industrias que producen bienes de alto valor agregado y radicados en las áreas de producción rural.

Generación de empleo por medio de industrias forestales del tipo doméstico basado en las materias primas.

Suministrar alimentos obtenidos directamente de las especies forestales en forma de flores, frutos, hojas, raíces, etc.

Marco Conceptual: De acuerdo a las consideraciones planteadas y a las funciones de lo forestal, es necesario que el marco conceptual del papel de la actividad forestal en las zonas áridas esté formulado con base a los siguientes principios:

Integración de las actividades forestales, agrícolas, pecuarias y de la industria rural en programas tanto sectoriales como multisectoriales.

Que la actividad forestal contribuya a un más amplio y sostenido desarrollo rural armónico, manteniendo un crecimiento económico y social con énfasis en el control de la desertificación, la seguridad alimentaria, producción de materias primas y otros bienes y servicios.

Función vital de las especies forestales para crear condiciones oportunas de producción agrícola y ganadera mediante cortinas de protección, conservación del agua, control de erosión, producción de leña, madera, forrajes, etc., buscando una mayor calidad y cantidad de productos en el menor tiempo posible.

Lograr beneficios económicos en los sistemas de producción tradicionales y empresariales procedentes de los recursos naturales y de la generación de empleos fomentando así el desarrollo rural.

OBJETIVOS GENERALES

Teniendo en cuenta los principios básicos del marco conceptual, los objetivos generales de la actividad forestal que deben considerarse en una estrategia para el desarrollo de las zonas áridas y semiáridas deberán estructurarse de acuerdo al siguiente arreglo:

Propiciar el desarrollo sostenido de la población rural de las zonas áridas y semiáridas y la seguridad alimentaria, sin menoscabo de los recursos agua, suelo y biota.

Mejorar el lugar que ocupa la actividad forestal con énfasis en la vegetación conspicua de estas regiones en un marco de manejo combinado, con miras a garantizar que todos los componentes del sistema contribuyen a la producción de bienes y servicios, al desarrollo económico-social y a la seguridad alimentaria.

Incrementar los beneficios que obtiene la comunidad rural de una utilización y elaboración apropiada de los recursos forestales de zonas áridas y hacerla participar en la expansión, diversificación, ordenación, conservación y restauración de estos recursos.

Hacer que en la actividad agrícola, ganadera, forestal e industrial en su conjunto y los recursos agua, suelo y biota de las zonas áridas y semiáridas, sean parte vital de los planes nacionales sobre un desarrollo económico-social armónico, brindando la seguridad de la obtención de bienes y servicios, la conservación de los recursos y la prevención de la desertificación.

Informar a los políticos y a la opinión pública sobre la importancia de lo forestal en el uso sostenido de los recursos; en la reducción de los daños y la degradación causada por la desertificación, la salinidad, las sequías, los fenómenos torrenciales, en el logro de la seguridad alimentaria y en el desarrollo rural.

Estos objetivos generales deberán traducirse en resultados concretos, entre ellos:

Mejorar la producción agrícola combinando prácticas agroforestales y adoptando medidas de conservación.

Desarrollar la producción animal combinando prácticas silvopastoriles incluyendo la plantación de árboles y arbustos forrajeros resistentes a la sequía en los planes de repoblación forestal y de ordenación de pastizales.

Disminuir el déficit energético mejorando la productividad de los recursos boscosos existentes.

Crear otras fuentes de empleo y diversificar los ingresos de la población rural mediante una mejor ordenación del recurso forestal en el marco del concepto de finalidades múltiples.

PROPUESTAS DE ACCION

De acuerdo a los principios del marco conceptual de la actividad forestal en zonas áridas y a sus objetivos generales, es necesario indicar una serie de propuestas para fomentar la aportación forestal con los propósitos de detener e invertir el proceso de desertificación, aumentar la capacidad productiva de la tierra, mejorar el nivel de vida y propiciar el desarrollo de ese tipo de regiones.

Para análisis de lo anterior se definen cuatro temas para desarrollar el plan indicativo de acciones de lo forestal en zonas áridas:

- Sistemas de producción
- Utilización y elaboración
- Conservación y restauración
- Políticas, instituciones y aspectos socioeconómicos

Sistemas de Producción

Los potenciales de desarrollo de las zonas áridas son limitados si se analizan y examinan en términos de cada posibilidad de uso de la tierra. Por ejemplo, la producción de cultivos, por falta de agua de riego, tiene posibilidades submarginales. Sin embargo, si se integra con la ganadería, las perspectivas son menos marginales. Si se integra además la actividad forestal, con hincapié en la producción, es posible que mejoren aun los potenciales de desarrollo. Cuando el desarrollo incluye las posibilidades que ofrece la ordenación de la fauna silvestre con los consiguientes ingresos y beneficios, es más probable que las perspectivas dejen de ser marginales y resulten rentables. Por tanto, el problema es cómo integrar y traducir, a nivel local, regional y nacional, los distintos sistemas de producción en planes y programas coherentes de ordenación del uso del suelo.

Sistemas Forestales

Los sistemas forestales en las zonas áridas se ocupan de la producción de leña y carbón, forrajes, madera de servicio (postes, estacas, etc.) y productos no maderables como gomas, alimentos, fibras, resinas, ceras, taninos, aceites esenciales y productos farmaceúticos. Se recomienda hacer hincapié en el desarrollo de la vegetación natural mediante el establecimiento de la base técnica administrativa y socioeconómica para el manejo de la vegetación.

Deberá darse prioridad a las acciones con arreglo a lo siguiente:

Desarrollo de información de base sobre tasas de crecimiento y rendimientos subsiguientes, mejores inventarios incluidos inventarios de material vegetal y clasificados por usos tradicionales.

Desarrollo de información para colocar las comunidades bióticas bajo la forma apropiada de ordenación que permita obtener rendimientos sostenidos a largo plazo, períodos de rotación, etc.

Ensayo de sistemas silvícolas mejorados para maximizar la producción forestal.

Mejora de las técnicas de regeneración tanto natural como artificial, incluyendo el desarrollo de fuentes de semillas, prácticas de vivero, preparación de los sitios y análisis de la calidad del sitio.

Sistemas de Producción Combinada: Los sistemas de producción combinada o los sistemas denominados comunmente agroforestales o silvopastoriles se definen como

sistemas en los que se practica la agricultura, la cría de animales y/o la actividad forestal en el mismo terreno, en rotación, simultáneamente o en el mismo espacio. La función del sistema es optimizar las posibilidades ecológicas y económicas de los distintos componentes para obtener una producción total mayor.

Examinar, analizar y difundir las experiencias disponibles en materia de sistemas de producción combinada (agro-pastoral y agro-silvo-pastoral) en las regiones áridas).

Análisis de árboles y arbustos que pueden servir para varias finalidades, catalogadas por regiones.

Desarrollo de plantaciones y técnicas silvícolas de bajo costo.

Selección y mejoramiento genético para preparar material de biomasa resitente a la sequía y de alto rendimiento, prestando atención especial a los árboles que fijan el nitrógeno.

Estudio de la compatibilidad entre la vegetación leñosa y los cultivos agrícolas.

Se recomienda que se elabore un programa nacional con alcance internacional sobre árboles y arbustos para las regiones áridas, y se garanticen los medios para coordinar los esfuerzos actuales y promover la utilización de los árboles y arbustos en beneficio de la humanidad.

También es recomendable intensificar los esfuerzos de investigación y desarrollo para que la utilización de la fauna silvestre llegue a ser una actividad aceptada y adoptada más ampliamente en zonas áridas.

Elaboración y Utilización

La elaboración y utilización de la vegetación leñosa y no leñosa, es quizás de importancia igual o mayor que el aumento mismo de la producción. Sin embargo, la elaboración sigue produciendo muchos desperdicios en muchos casos (por ejemplo en la producción de carbón). En este contexto, se necesita una mejora considerable para evitar desperdicios de recursos.

Se proponen las siguientes actividades para mejorar la elaboración y utilización de la vegetación y fauna silvestre de zonas áridas:

Vegetación: Mejorar los conocimientos sobre propiedades físicas y químicas de las especies nativas y exóticas.

- Desarrollo de industrias caseras y de otros tipos, que sean apropiadas.
- Mayor uso de residuos de cosecha y elaboración.
- Cosecha de flores, hojas y otras partes de plantas.
- Intensificar la búsqueda de plantas nativas e introducidas de valor económico potencial.

Fauna Silvestre: Mejorar los sistemas de recolección

- Estudios de mercado

Conservación y Restauración

Los recursos naturales se están destruyendo rápidamente, lo cual afecta seriamente a la población humana y a su entorno. Los frágiles ecosistemas de zonas áridas están bajo presión lo que junto a las fluctuaciones climáticas significan desertificación y degrado ambiental sin precedentes; al mismo tiempo la domesticación, selección y mejora genética de especies de importancia económica están homogeneizando sus poblaciones sin que se preste la debida atención de las valiosas variaciones que la naturaleza ha desarrollado a lo largo de milenios y que se encuentran contenidos en los ecosistemas naturales.

Las acciones de conservación y restauración que se recomiendan son:

Aumentar el conocimiento sobre la mecánica de la erosión, la erosividad de la lluvia por regiones, por tipo de suelos y demás factores que intervienen en el proceso.

Promover la investigación enfocada a generar información práctica y de aplicación inmediata para el combate de la erosión y el incremento de la productividad del suelo, acorde con los sistemas de producción y con las realidades financieras.

Vincular estrechamente la investigación con los grupos operativos encargados del diseño de programas de asistencia técnica en materia de conservación.

Generar y validar métodos de conservación del suelo a través de cortinas protectoras y cortavientos; control de la erosión eólica y fijación de dunas por medio de técnicas de manejo de la cubierta vegetal, técnicas de preparación de suelos y rotación de cultivos; desarrollando información sobre la disminución de la erosión, el incremento en la productividad y las relaciones beneficio/costo.

Desarrollar tecnologías para la rehabilitación de tierras residuales y salinas.

Desarrollar esquemas de conservación de germoplasma de especies vegetales y animales que permitan salvaguardar la diversidad genética contenida en los diferentes ambientes de las zonas semiáridas para uso inmediato y de las generaciones futuras. (Conservación in situ en áreas protegidas y ex situ a través de un banco de germoplasma).

Utilizar la biotecnología como herramienta de investigación para solucionar problemas de plagas, enfermedades y reproducciones de individuos altamente productivos.

Integrar la fauna silvestre en los programas de desarrollo forestal y uso múltiple del suelo.

Creación de áreas protegidas en zonas áridas y semiáridas que pueden incluirse en el programa de la biosfera.

Validar prácticas de manejo de las poblaciones naturales de especies de flora y fauna que permita la protección y equilibrio de los ambientes ecológicos incluyendo los aspectos sanitarios y de incendios.

Diversificar las fuentes de empleo e ingresos de la población rural mediante una mejor ordenación de los recursos naturales en el marco del concepto de finalidad múltiple, incluyendo la fauna silvestre.

Políticas y Aspectos Socioeconómicos

Las estrategias y tácticas comunes para aplicar políticas forestales en zonas áridas que han tenido éxito son raras; el único común denominador que pueden encontrarse en estos casos es un compromiso básico a nivel de gobierno central y su capacidad técnica y administrativa de adoptar medidas de envergadura suficiente para provocar los cambios decisivos necesarios en el uso de la tierra y la cubierta vegetal.

Los siguientes principios rectores pudieran servir, para orientar la definición de políticas para las zonas áridas y semiáridas.

La actividad forestal debería ser un componente de la ordenación integrada y multidisciplinaria de la tierra.

Las operaciones forestales deben realizarse para la gente y con la gente, basándose en iniciativas voluntarias activas y en la participación de la población local, con objeto de mejorar los niveles de vida.

Las acciones deben basarse en una compresión sólida de las relaciones socioeconómicas y las tradiciones de tenencia y uso de la tierra en la zona.

La legislación forestal debería servir eficazmente a la política forestal, basándose en la comprensión y aceptación popular, en armonía con otras leyes sobre la tenencia y uso de la tierra.

De acuerdo a lo anterior se sugieren las siguientes estrategias como altamente prioritarias para la aplicación de políticas forestales en zonas áridas.

Hay que diseñar mecanismos para integrar la labor de la investigación, capacitación, extensión y ejecución forestales.

Hay que preferir las técnicas baratas de difusión del impacto de las actividades, a las técnicas costosas con un impacto mínimo en zonas pequeñas.

El uso de incentivos fiscales y económicos para promover objetivos de política.

Dentro de los límites de una ordenación prudente, hay que preferir los métodos de uso intensivo de mano de obra a los de uso intensivo de capital.

La obtención de información sociológica, histórica y económica debería ser un paso fundamental en la planificación.

Los lugares que merecen atención especial son: áreas salinas, dunas arenosas, los lugares más gravemente degradados y los lugares valiosos más vulnerables.

Al analizar el marco conceptual, sobre el papel de las actividades forestales en las zonas áridas, se deduce que esta actividad es un componente inseparable del sistema total del uso de la tierra y puede aportar una contribución vital en la lucha contra la desertificación y a la seguridad alimentaria; desde luego la estraegia de desarrollo debe encaminarse hacia la "Gestión de Calidad Total" promoviendo el espacio de la producción con la agroindustria y comercialización, a fin de maximizar la inversión de recursos en función de la búsqueda creciente del bienestar de la población rural.

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Sustainable Economic Development in Rural Areas: Balancing Economics and Ecology in Rural Economic Development

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Abstract.—Recently, there has been an increasing recognition of the need for rural communities to improve their economic development efforts, while being more sensitive to, and compatible with, the protection and maintenance of the natural environment. This paper outlines elements of an approach to sustainable economic development in these rural areas, emphasizing the need for cooperation and coordination for the common good of the community and natural environment. Six components of sustainable economic development are discussed, they are: Community leadership, Federal State and Local Cooperation, Development Strategies, Land Stewardship and Ecosystem Management, Financial Efficiency, and Future Generations. Following this discussion a case study of an on-going rural economic development effort in Southwest Colorado is presented which incorporates precepts of sustainable economic development.

INTRODUCTION

During the late 1980's and early 1990's, the concept of Sustainable Development and more generically, Sustainability, has become prominent, especially in the economics and ecology literature.

In rural areas of the Western United States, where landownership patterns are dominated by large tracts of public lands, economic development potential of local communities and counties has been seen as closely tied to the natural resource base (particularly the commodity portion) contained within these public lands. Traditionally, this view has lead to a heavy reliance being placed on these federal lands for continued production of commodity products, such as forage for the ranching industry, timber for local woods product industries and access to mineral deposits for the mining and oil and gas industries. During the past twenty plus years, non-commodity amenity uses, such as hiking, camping, picnicking, and wildlife viewing, of these public lands have become increasingly important, both socially and economically. As a result, fierce public debate and confrontation has occurred in a effort to define the "best" overall mixture of these public land uses for meeting the demand for both commodity and amenity resources.

At the same time, another policy debate has taken place regarding the overall sustainability of the ecological land and water systems on which the various land uses depend. In the past, sustainability was generally considered as a flow problem (sustained yield) of renewable resources such as timber and grazing. Today, it is understood that sustainability concerns extend beyond the flow of economic resources, to the sustainability of the ecological system, itself. It has become apparent that the demands being placed on these lands (public and private) for the whole range of uses has, at times, put an intolerable burden on the ecological productivity and assimilative capacity of these natural assets.

The purpose of this paper is to address six components important to economic development as they relate to economic and ecological sustainability of rural areas in the Rocky Mountain West (DeVilbiss, 1991, 1992). These components of sustainable economic development are

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described, followed by a case study currently underway in Southwest Colorado, which addresses many of the components presented.

SIX COMPONENTS OF SUSTAINABLE ECONOMIC DEVELOPMENT

Although all six components (See Figure 1) are equally important to the success of sustainable economic development, they may be viewed as interacting among each other in a manner meant to produce effective development strategies that incorporate the basic requirements of each component.

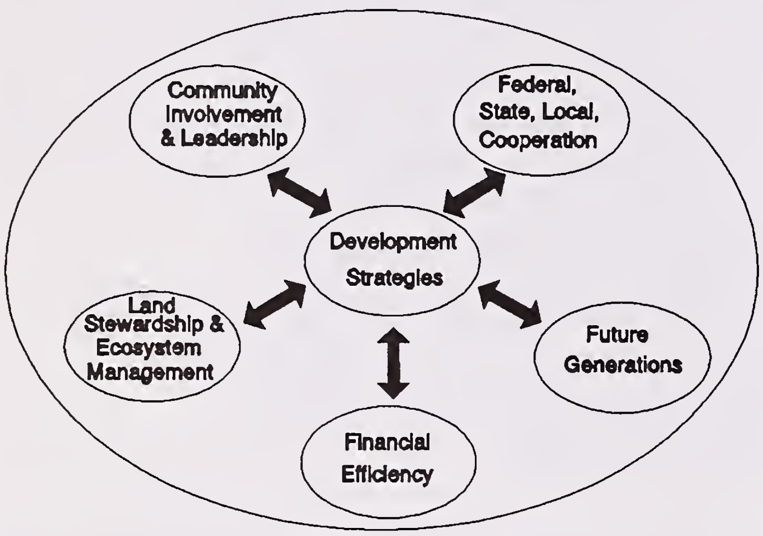

Figure 1. — Sustainable economic development, the six components.

Community Involvement and Leadership

As with most human endeavors, especially those relating to policy formulation, quality of leadership usually dictates the effectiveness of the outcome. With respect to public policy, success also is strongly influenced by the amount and quality of local public involvement. This leadership and public participation usually involves individuals from many areas of local, state and national government and non-government, each working with and influencing one or several portions of collective community effort.

For local economic development efforts to be successful, and fulfilling of local goals and aspirations, they must be the product of active <u>local</u> community involvement and leadership. Whereas, outside resources often need to be brought into the local development effort, leadership for identifying the values and goals of local communities and counties must be initiated locally or risk being usurped by "outside" influences. Successful economic development efforts are "owned" and controlled by local communities. Although, involvement of many public agencies and private concerns are needed for successful development, local political leadership cannot be substituted.

Given the complexity and interdependencies inherent in community development efforts, community leadership must recognize the need to be inclusive and balanced among many local interests. Communities are most often viewed as "places", but these communities of "places" at the same time are communities of many different "interests and cultures." Without the active support and involvement of a cross-section of these varied backgrounds, community and economic development progress would be at cross-purposes and counter productive.

Leadership must be proactive and forward-looking. We live in a rapidly changing and competitive world. Communities must be willing to take the initiative to define the future they, collectively, wish to create for themselves.

Some rural economic development participants include:

1. Local government leaders, including their economic development staffs,

2. Federal, and state agencies, Native American tribes, and

3. Publics, industry, and private landowners.

Primary leadership rests with county and community governmental leaders (county commissioners, mayors, and city managers) including tribal leaders where Native American tribal lands are involved, in close association with their designated economic development staffs. These individuals represent the interests and values of the members of their communities and areas, and as such, are responsible for identifying the collective values and goals of the community, as well as for local coordination and political decision making. On tribal reservations, local Native American tribal leaders have leadership responsibilities over their tribal lands, and do not relinquish this authority to local political entities in the area of economic development.

To be successful over the long term, local leadership must coordinate and cooperate closely with the other major participants, however, primary responsibility and accountability for economic development remains with the local elected officials.

Managers of the federal and state lands depend on local and regional interests for the markets and user support for the activities which are proposed for these lands. Although control and decision making responsibilities remain with each land holder, often it is in the best interests of each party to coordinate their respective policies with those of their neighbors. As is often the case, local economic development strategies depend to a significant extent on these lands for economic activities.

Equally important, federal and state land holding agencies have planning resources, such as inventories, data bases, and expertise in given areas which can be invaluable

to local economic development staffs. Coordination of these technical aspects of economic development can be cost effective and time-saving to all parties.

Although local elected officials have responsibility for implementation of economic development efforts, publics, industry, and private landowner groups are responsible for participating in the processes that establish values and priorities. It is often within the ranks of these groups that many individual leaders maybe found.

Federal, State, Local Cooperation

Although local community leadership is the first requirement for success, an important second requirement is the need for cooperation and coordination among a wide variety of governmental and private groups. Partnerships comprised of local political groups, economic development groups, federal and state agencies provide the basis for a "pooling" of resources. This is critical for rural areas in which landownership patterns include large segments of public lands. Often these public lands contain many of the amenity and commodity resources needed by the community to pursue its economic development potential.

Coordination among government entities includes these four elements:

1. Establishing partnerships and coordination frameworks,

2. Identifying values and coordinating goals,

3. Coordinating planning resources and assumptions, and

4. Coordinating funding for rural development initiatives.

Formal partnership requirements need to be established between various interests. These partnerships create coordination frameworks between the local economic development authority and associates such as federal agencies and state offices. A primary objective of these partnerships is to form an economic development process that is inclusive of all affected interests and balanced in its approach to meeting the goals and aspirations of all affected parties. This coordination is proactive in the sense it involves all major interests "up front", at the beginning of the economic development effort, rather than later in the process when groups would be forced by circumstances to respond in a reactionary, and often counterproductive fashion.

There are as many views of progress in a given rural area as there are major players. The values of these players may be expressed in published documents such as Forest Plans or County economic development action plans or may be unwritten or, perhaps, unstated. Although each group has a responsibility to their constituents to represent their interests in terms of appropriate goals and policy statements, sustainable economic development requires that these values and goals be stated explicitly, so they may be addressed in a coordinated fashion. In coordinated economic development activities, identification of common assumptions across all major players is critically important.

Coordination of technical planning resources among and between the major participants is crucial to the success of economic development efforts in rural areas. This coordination extends to setting up mechanisms for sharing of data bases and inventories. Also, cooperative support of highly technical and often expensive planning activities such as economic and ecosystem modelling, development of Geographical Information Systems (GIS) and integrated resource inventories is highly desirable and cost effective.

There are a number of sources of funding that are available to local economic development efforts, particularly on a cost-sharing basis. Obviously, these sources should be identified and coordinated as early in the effort as practicable. Examples include the Rural Revitalization Through Forestry and the US Forest Service Economic Diversification Study Grant Program, both programs focus on helping rural communities explore ways to diversify their economies; other programs are also available.

Development Strategies

To a large measure, economic development goals are defined by the human, natural and economic resources available. A community's economic development strategies (portrayed as the focus of interactions with the other five components in Figure 1) must be based on a realistic appraisal of its unique set of resources, to develop the various options or strategies through which these resources may be mobilized.

In both cases, appraisal of resources and identification of options and strategies, the economic development effort moves into more technical areas of economic analysis, development planning, and resource inventorying which are often expensive and time-consuming. To insure the economic development planning effort is cost effective, it is essential that coordination and sharing of these technical resources occur on a continuing basis. Also, values and goals identified by the community should be expressed as formal problem definition statements that can be used to guide the development of data bases and mapping systems, analysis of economic, social, demographic and environmental conditions and opportunities, and the identification of alternative development strategies.

A wide range of technical activities are involved in formulating sustainable economic development strategies. They include: economic modelling of the local economy, which typically involves the construction and use of

economic input-output models, and modelling ecological systems (ecosystems) within which the rural community is located.

The task of economic input-output modelling is to define the overall rural economy(ies) on which the various communities depend and develop economic profiles of the economy(ies). An example of such economic profile information is the *Economic Diversity and Dependency Assessment* prepared for the Rocky Mountain Region of the US Forest Service (DeVilbiss, 1992). In addition, economic input-output models may be used to evaluate development strategies.

Although a relatively "newcomer", ecosystem management is one of the more important economic development considerations; its discussed later in a section entitled: Land Stewardship and Ecosystem Management. For purposes of defining sustainable economic development strategies, ecosystem management involves establishing baseline conditions, including ranges of natural variability, which in part define the integral ecosystem(s) and provides a basis for judging the viability of economic development options within those ecological limits. In this manner, "conditions of use" may be established for ecosystems such that their continued stability and integrity is maintained and protected. This assessment of ecological carrying capacity is critical to establishing the "scale" of economic activity that may take place within the ecosystems on a sustainable basis (Daly, 1992). Using ecosystem and economic modelling, in tandem, sustainable economic development strategies and desired future conditions (ecological) may be analyzed and evaluated.

Various economic, demographic and environmental inventories need to be conducted, computer-assisted data bases developed, and spatial geographic information systems established. As mentioned above, these activities can benefit greatly from cost-sharing arrangements, coordination of initial data requirements, and close cooperation and coordination among participants.

Economic development options available to local communities are defined only partly by the natural resource base on adjacent lands. Far more important to potential economic development success is the range of existing or potential local economic activity, much of which may have very little connection with the adjacent natural resource base. Community leaders need to consider a wide set of options such as: substitution of locally produced materials currently imported into the economy; value added manufacturing activities which increase the extent of production within local economic boundaries; and increased efficiencies through training programs for the local workforce, to name just a few possibilities.

Obviously, alternative economic strategies should be evaluated in terms of their overall potential for achieving the goals set by the community, including the tradeoffs inherent in such goals. Two areas of evaluation that should be considered with respect to sustainability are financial efficiency and the effects of each option or strategy on future generations. Both areas are discussed further below.

Throughout the sustainable economic development effort is a strong and continuing public involvement process. Members of the public can provide excellent review and comment on the analysis and evaluation of alternatives. Public involvement efforts need to continue throughout the entire planning process including selection of the final economic development strategy.

Land Stewardship and Ecosystem Management

Arguably, the most important component of "sustainability" with respect to local economic development, is its relation to the ecosystems within which it is located. The sustained viability of local communities and their economies depends directly on the ecological integrity and stability of the land and water ecosystems in which they "reside." It should be recognized that local economies exist within local ecosystems, not the reverse. As such, sustainable economic development depends on a deep and abiding land stewardship ethic which places paramount importance on the protection and maintenance of ecosystem integrity and stability. Reaching agreement on such a land ethic should be a primary focus of federal, state and local cooperation and public involvement efforts.

"Sustainability" asks that economic development efforts recognize two fundamental concepts. First, that care and nurturing of the ecological environment be valued by the community on a par with the value placed on the economic wealth to be generated by the ecological environment. Obligations and responsibilities to the land need to be defined and supported in a land stewardship ethic that are apparent in actions taken to protect and preserve the life- (and economic-) sustaining force of the ecosystem. Second, given such a land ethic, economic development needs to incorporate an understanding of the "mechanics" of how such ecosystems functions and what their carrying capacities are relative to alternative economic development strategies. This is the function of ecosystem management.

There is widespread interest currently in the idea of ecosystem management. Efforts to define "ecosystem management" need to include consideration of the "scale" (size) of the economic activities that are sustainable by complete and functioning ecosystems (Daly, 1992). Establishing this "scale" of human activity within ecosystems involves both "ecological" and "social" decisions. Each ecosystem has a natural limit (carrying capacity) for providing physical goods and services, and to assimilate wastes from human activities. "Ecological" decisions need to recognize these ecological limits. The

"social" decision incumbent on the political decision making process is to recognize the ethical imperative of adhering to these ecological capacities.

Depending on the nature of the economic activity contemplated (e.g., highly toxic or benign), appropriate economic scale will vary accordingly. Overall, it is set by the carrying capacity, or range of natural variability, of each ecosystem. These ecological conditions need to be identified and understood early in the economic development process as they set the side-boards, or conditions of use, under which long term sustainable economic development can occur. Within these ecological conditions of use, a range of economic development strategies will be sustainable.

Financial Efficiency

Economic development strategies have the potential to impose costs, revenues and benefits on various parties quite differently. Each participant, and often other parties not directly participating, should be aware as to how various options and strategies may affect their individual financial welfare. If costs are being imposed disproportionately, the effected group or individual, will be motivated to undermine the development process so as to protect their particular interests. In this regard, the financial efficiency of all participants, both public and private, needs to be considered.

In the interest of society (tax-payers) as a whole, when governmental land management costs exceed revenues, such subsidies should be recognized explicitly. Of course, public agencies are not required to produce positive net revenues from their activities as must a private sector business. However, for long-run sustainability, all public and private economic resources should be employed as efficiently as possible. Where public programs are provided "below cost", the extent to which those programs or projects are provided below cost, and the reasons for providing them should be made apparent to the public. As with natural ecosystems which have sustainability limits, the financial resources of a nation, state or local economy are also limited. These ecological and financial limits need to be considered in evaluating sustainable economic development strategies.

Future Generations

Implicit in the term "sustainability" is the notion that sustainability refers to the long-term, particularly a span of time which extend beyond a single generation. Thus, for economic development to be sustainable it needs to consider future generations, as well as today's generation. This is particularly important with regard to ecological sustainability, although, a similar argument can be made for financial sustainability.

A point made in the section on Community and Economic Development above, bears repeating here. Since all economic activity occurs within the context of the ecological environment (ecosystems), the ecological productivity and assimilative capacity of ecosystems for future generations should set the "sideboards" or constraints, within which current economic activity occurs. It is important that scientific ecological studies provide the information necessary to set these constraints for economic development strategies. Irreversible and irretrievable decisions should be taken with extreme caution. Preference should be given to activities that increase future options and/or which decrease environmental and economic costs to future generations.

In the following case study section, these six components of sustainable economic development are discussed (and depicted in figures 3, 4, and 5) as they relate to an on-going rural economic development effort. This project was initiated by the Montezuma County Commissioners, the Mancos Valley Task Force, and the Region 9, Economic Development District in Southwest Colorado. The process of actively incorporating these six components in local economic development is evolving over time and some elements are more prominent than others.

A CASE STUDY IN SOUTHWEST COLORADO

This case study will focus on Southwest Colorado, an area which is in the geographic and cultural transition zone between the Rocky Mountain West and the Colorado Plateau. Southwest Colorado is typical of this part of the West with an economic history based on mining, agriculture and timber, with significant growth in recreation and tourism in recent years, and large amounts of Federal ownership (65% of the land base of Southwest Colorado).

In discussing sustainable economic development much attention is given to the need for increased coordination and cooperation among all major participants in particular localities. However, it is important to recognize at the outset that in Southwest Colorado, as in many other rural areas of the Western United States, these concepts of sustainable economic development and sustainable ecosystems are being discussed and debated in a polarized and emotionally charged context. As outlined above, it suggests that truly *sustainable* economic development depends on an ability of local communities to shape common visions for the future, based on many different and, often times, conflicting perspectives.

This "polarized and emotionally charged" context can best be understood by two differing perspectives that are characterized as "The New West Perspective" and "The Traditional West Perspective."

Those espousing "The New West Perspective" see extractive industries as playing a declining and relatively minor role in rural development, being replaced by an emphasis on continued growth in tourism and resorts. This New West Perspective foresees increased economic activity relating to a spin-off of "quality of life" relocations by businesses and retirees, and by people who are "occupationally-mobile" and able to make a living based on modern telecommunications technology (a modem and fax machine). Whereas, in the view of some individuals the "Traditional West Perspective" exploited the land by cutting down too many trees, overgrazing the range and reckless mining practices, the "New West Perspective" is seen as having relatively minor impacts on the land.

In the case of "The Traditional West Perspective", advocates see rural people as working the land and producing the raw materials that fuel the American economy. They believe rural people have taken care of the land for a hundred years because their livelihoods depended on it. Now, they see new government policies being proposed that would take away private property rights and rural livelihoods. The "Traditional West Perspective" is that most damage to the land was done when those lands were in the public domain. They believe private property rights and grazing allotment permits give the responsibility and the incentive to improve the land through a lot of hard work, and thereby continue to be part of the backbone of the American economy.

In the current political climate it is easy for concepts like "sustainability" and "ecosystem management" to be taken as code words for these perspectives and the polarization that they reflect. Economic and ecological sustainability are abstract concepts that only take on concrete meaning when they are applied to the relationship between particular natural and man-made settings. The leadership challenge is to move from these polarized perspectives to a common vision about the land and its relationship to the future of rural economies and local communities.

The elements of the polarization that has been described in terms of "Traditional West" and "New West" perspectives are certainly present in Southwest Colorado and, in various mixes, within each of its five counties. The challenge to leadership is to bring the values associated with these perspectives into a dialogue which is guided, in so far as possible, by an agreed upon set of factual information, data and assumptions.

It is also important to recognize that there are interests external to the local communities (such as environmental organizations and lease holding energy companies) that have an interest in this dialogue. Such interests need to join the dialogue within the local context in a way that respects community and ecological settings and comes to grips with their interrelationships and the consequences of proposed actions on these settings.

This case study focuses on three areas (See Figure 2): the Mancos Valley, Montezuma County (in which the Mancos Valley is located), and the Southwest Colorado Region 9 (Archuleta, Dolores, LaPlata, Montezuma and San Juan Counties).

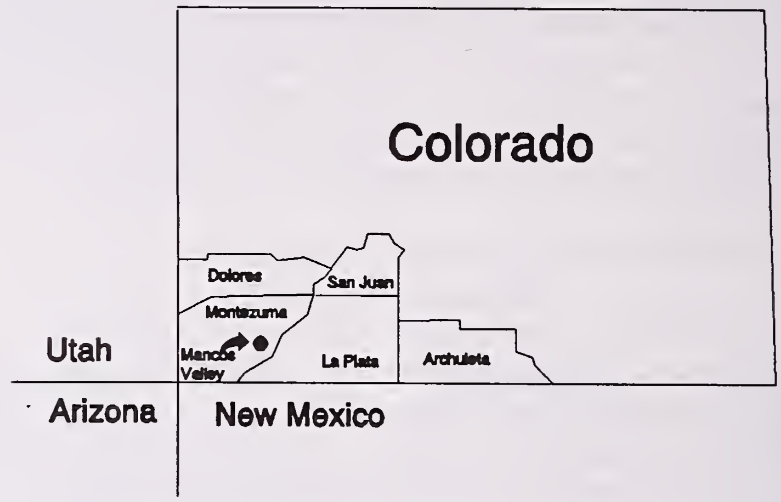

Figure 2. — Southwest Colorado vicinity map.

The Mancos Valley

The Town of Mancos (population 800) is located along Colorado Highway 160 about midway between the two largest population centers in Southwest Colorado: Durango (population 13,000, the county seat of La Plata County) and Cortez (population 7,000 the county seat of Montezuma County). Highway 160 is the connecting link from Southern California, across the Navajo Reservation, through the Four Corners to Durango and points east in Colorado.

To the east of the Mancos Valley, Durango and the Animas Valley is the most "New West" of Southwestern Colorado communities, which includes Fort Lewis College, a ski area, a strong tourism and resort sector, an extensively renovated historic downtown, and an upscale housing and land market. To the west of Mancos, Cortez and the Montezuma Valley is a more "Traditional West" community with tourism growth (based on extensive archaeological resources) taking place in a community that still reflects a strong orientation towards the ranching, farming, energy development, timber and retail trade with surrounding agrarian and Indian reservation communities. It is a scenic irrigated ranching valley, surrounded by public land (San Juan National Forest, Mesa Verde National Park, Bureau of Land Management, and Ute Mountain Indian Reservation).

The Town of Mancos had been bypassed by Highway 160 and by mid-1980s the historic downtown had become nearly vacant, as businesses went under or moved out on the highway. But the people of the Mancos Valley had a vision that involved bringing the downtown back to life in a way that brought the Traditional West heritage of the Valley together with New West opportunities offered by being on

the Highway 160 Corridor to Durango. This vision was initially set out in a plan put together by the Mancos Valley Task Force, assisted by the Office of Community Services at Fort Lewis College and sponsored by the Mancos Valley Association, the Mancos Town Board and the Montezuma County Commissioners (See Figure 3, Leadership component).

The Task Force, with representation from all the jurisdictions and philosophical orientations present in the Valley, developed, delivered and picked up a comprehensive survey to which 85% of the households in the Valley responded (See Figure 3, Cooperation component). Based on the survey response and over a year of additional research and analysis, a report entitled "The Mancos Valley . . . A Better Place to Live" was completed in 1987. A newsprint summary of the report was published as a newspaper insert, with a thousand extra copies printed. The summary outlines a series of themes, with specific issues and recommendations under each theme. As of 1993, virtually all of the recommendations have been, or are being, implemented.

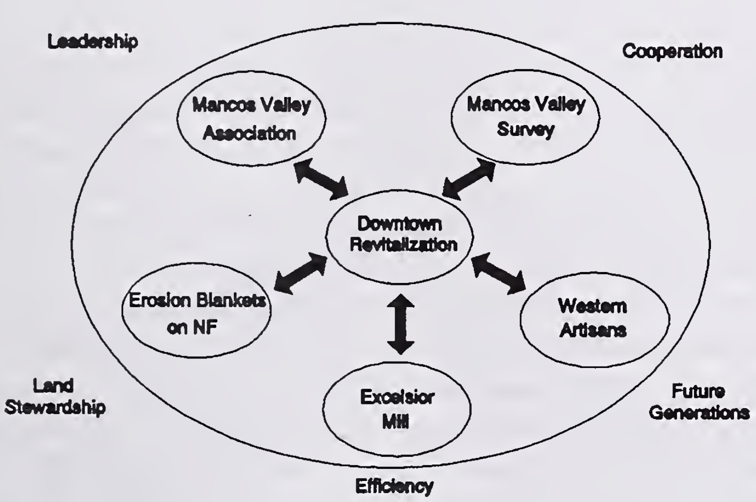

Figure 3. — Sustainable economic development, Mancos Valley.

Three elements of the plan are worth focusing on because of their relevance to our discussion of sustainable economic development that integrates the best of both the traditional west and new west perspectives. These elements include (See Figure 3, Development Strategies):

1. People wanted to revitalize the historic downtown (nearly vacant at the time), based on a combination of artisan production and retail space. The intent was that the retail space would draw in visitors and production space would generate craft exports and additional employment.

2. People wanted to acquire a Forest Service storage building located along the highway to use as a visitor center to direct people to outdoor recreational opportunities and the Downtown (once it was revitalized.)

3. People wanted to make a concerted effort to protect the small town character of Mancos, and the agricultural character of the Mancos Valley (which includes cattle ranching and a timber mill).

While not much happened immediately after the completion of the plan, the newsprint summary continued to circulate. A local Realtor who had served on the Task Force distributed the plan summary to prospective property owners. As a result, many of the people that bought property in the Valley, bought into the plan. Some of these new residents evolved into leadership positions of the Mancos Valley Association including the current Chairman and Mancos District Ranger for the Forest Service.

The Forest Service Building along Highway 160 has been made available to the community and is serving as a visitor center providing information about outdoor recreational attractions and historic Downtown Mancos. The Downtown has been revitalized based on private sector western crafts production and retail shops including a carriage maker, a hat and boot maker, and a saddle maker (See Figure 3, Future Generation component). These products and the Town are being promoted and exported nationally.

The owner of Western Excelsior, the aspen mill in Mancos has provided substantial capital towards the Downtown revitalization. Western Excelsior employs a work force of 50 people to produce biodegradable packing excelsior, erosion blankets, cooler pads and fruit pads out of National Forest aspen (See Figure 3, Efficiency component). Their erosion blankets are being used to improve riparian areas on the Forest. Western Excelsior is also putting together a "hammer mill" to mix recycled newspaper with excelsior by-product to produce a weed free mulch (See Figure 3, Land Stewardship component).

The private sector integration of Traditional West and New West economics that is reflected in the relationship between Western Excelsior and Downtown Mancos, is being carried over into the public sector. The Visitor Center is being expanded with displays of the natural resources heritage of the Mancos Valley and surrounding Forest. The displays will provide environmental education, in the context of rural natural resource communities, to the hundreds of thousands of urban visitors with little personal exposure to rural living and livelihood.

Montezuma County

At the County level, the Montezuma County Commissioners established a Federal Lands Program in February of 1992 (See Figure 4, Leadership and Cooperation components). The purpose of the program is to bring local government, local business and federal land management agencies into a partnership to understand the economic and ecological relationship between federal and public land uses; to jointly evaluate federal/private land use policy, planning and management issues; and to maximize informed, broad based, front end citizen involvement in addressing these issues.

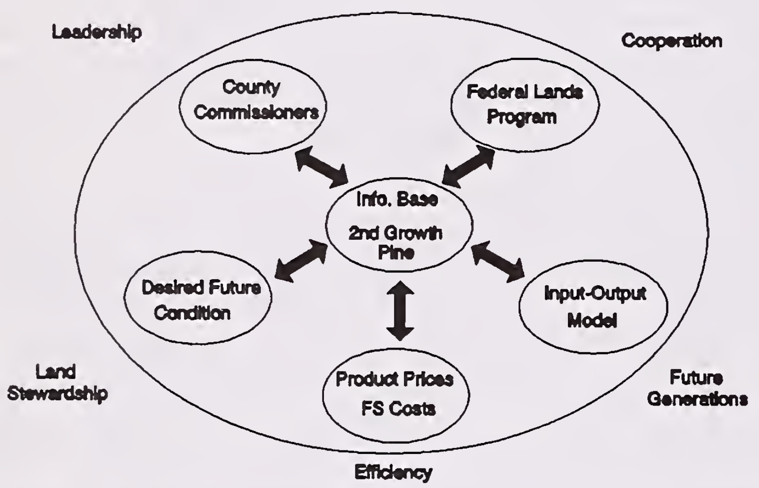

Figure 4. — Sustainable economic development, Montezuma County.

The Federal Lands Program, assisted by the Office of Community Services at Fort Lewis College, has coordinated resource oriented field tours with county commissioners, federal land managers, and federal land users focusing on economic and ecological issues. Strategic efforts at agency, county, and business collaboration to address immediate problems and opportunities have resulted from this dialogue.

Economic sustainability involves both increasing and protecting economic diversity. Economic diversity needs to consider all types of economic activity, both Traditional West and New West-related. To use an example from the Mancos area, Western Excelsior's diverse line of biodegradable products and markets have been developed over 20 years out of a match factory that has since gone out of business, and profits have been reinvested in Downtown renovation. Factors affecting these business activities, such as availability and price of aspen in the case of Western Excelsior, could affect the economic diversity of Mancos.

Efforts are underway to refine organizational linkages between federal and local entities and to develop a common information base useful in addressing ongoing economic and ecological issues and setting the stage for major revisions in land and resource management plans. Description of partnerships to develop economic and geographic information will be followed by a brief description of an ecosystem management project that will utilize these tools (See Figure 4, Development Strategies).

In the past, communities and public agencies have lacked the tools to evaluate the economic impact of expansion or contraction in economic diversity, and evaluate the relative merits of potential economic development initiatives and resource uses. Montezuma County had embarked on an effort to work with an economist from Colorado State University who specializes in input/output models which measure total changes in local economic activity when outputs in a particular sector are increased or reduced. The county federal lands coordinator, from Fort Lewis College was gathering local economic data. The Forest Service had developed an I/O model known as "IMPLAN" (Taylor, et al., 1992), and conversations between the federal lands coordinator, and the Rocky Mountain Regional Economist for the Forest Service resulted in combining these efforts to refine IMPLAN to the local setting and use it to assess economic diversification alternatives. This partnership which began in Montezuma County is being extending to all of Southwest Colorado to develop an economic model that can fill this need.

With the economic model providing the information base for active collaboration and public involvement on economic sustainability, there was a need for new tools to consider ecological sustainability. What has emerged is a partnership on the part of local, state and federal entities to develop a Geographic Information System (GIS) to deal with sustainability issues in an ecological context.

The Colorado Department of Transportation is providing Montezuma County with hardware, software, training and a data base on the state and county road system that covers the entire county with links to the same data for the other counties in the Region. The Forest Service is conducting a pilot GIS project in connection with an Integrated Resource Inventory (IRI) on the Dolores Ranger District (located in Montezuma County). The Dolores Water Conservancy District, in cooperation with the U.S. Bureau of Reclamation is putting together GIS mapping on an area which includes 28,000 acres of land irrigated out of McPhee Reservoir under the Dolores Project. The recreation facilities on McPhee Reservoir are managed by the Forest Service and will be included in the IRI pilot creating contiguous GIS projects.

Coordination has begun to integrate State road data, County utilities data, Forest Service natural features and landscape management data, and Dolores Project facilities and land ownership data into compatible layers to pilot multi-agency interface and provide a data base that integrates federal and privately owned lands. These layers will be applied to an ecosystem management project entitled, "Ecosystem Management in the Second Growth Pine Zone of Southwestern Colorado: A Model for Forest Service, Community Collaboration" (See Figure 4, Development Strategy). The project grew out of a Montezuma County,

Forest Service, and local industry field trip in which the Dolores District Ranger indicated that there were tens of thousands of acres of stunted second growth ponderosa pine on the San Juan Forest that needed thinning. Thinning would reduce the high risk of pine beetle infestation and catastrophic fire, and create an opportunity for more diverse sizes and classes of trees while increasing forage, plant diversity and improving wildlife habitat.

The predominance of small diameter material in this 180,000 acre pine zone has made it difficult to put up viable sawtimber sales at currently escalating prices. The Forest Service lacks funds to conduct pre-commercial thinning on any meaningful scale. A chip operator from Denver inquired locally about material to chip for sale to a paper mill. This opportunity was discussed by County, Forest Service and industry representatives resulting in an option that could improve ecological conditions, partially overcome a timber shortage, protect existing jobs and create new jobs in a financially efficient manner.

The intent is to develop a stewardship arrangement in which industry thins the pine zone to a "Desired Future Condition" (See Figure 4, Land Stewardship component) using a combination of chipping and logging with the different outputs priced appropriately. The Desired Future Condition for this area, along with projected volumes and rates of output, will be determined through a process which combines detailed scientific analysis and extensive public involvement.

The Forest Service will conduct an interdisciplinary analysis on three major landscapes which incorporate much of the pine zone that needs treatment. GIS will be used to analyze and display existing conditions as well as alternative future conditions and commercial outputs. The economic input-output model will be utilized to evaluate the economic consequences of the various alternatives. The County will take the lead in staging a public involvement process which brings together people with ecological, economic, and recreational interest in the project to assess the alternatives and select and refine a preferred alternative.

The intent is that the pine zone project will pilot methods for interfacing technical economic and ecological information with broad based public involvement as a precursor to the San Juan National Forest Plan Revision scheduled for initial public involvement in late 1994. Since the San Juan Forest Plan will involve all of Southwest Colorado it is appropriate to move to the regional component of the case study.

Southwestern Colorado Region 9

Montezuma County participates with the other four counties and ten towns in Southwest Colorado in the Southwest Colorado Region 9 Economic Development District (See Figure 5, Leadership component). The issues and strategies raised in the Mancos Valley and Montezuma County case studies are beginning to be addressed in a regional context through the District, which provides a forum that links public officials and business leaders throughout Southwestern Colorado.

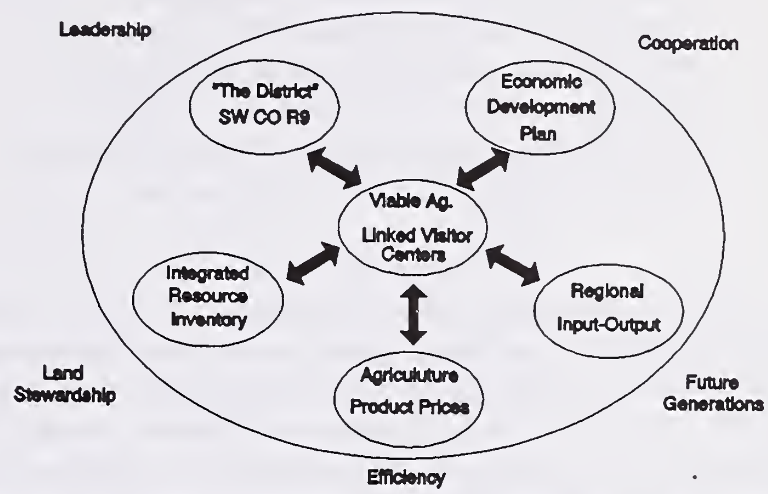

Figure 5. — Sustainable economic development, SW Colorado Region 9.

The District, through a contract with the Office of Community Services at Fort Lewis College, is nearing completion of a regional economic development plan (See Figure 5, Cooperation component). The plan is jointly funded by the Economic Development Administration and the Rural Revitalization through Forestry Program of the U.S. Forest Service. Public meetings have been held throughout the region to determine community level and regional goals and action strategies for economic development.

Many of the economic development issues and opportunities (See Figure 5, Development Strategies component) that emerged in the Mancos Valley and Montezuma County have proven to be regional in nature. For example:

1. There is a Regional interest in linking visitor centers, such as the one in Mancos, via the Scenic By-ways program and joint tourism promotions as a means of circulating tourists to the smaller communities. "Heritage tourism" and its relationship to the Region's historic natural resources economy is of interest throughout the Region.

2. The continued viability of agriculture is valued, not only for its direct economic contribution, but for the key role it plays in preserving open space, wildlife habitat, and the general aesthetic and cultural character of the Region (See Figure 5, Financial efficiency component).

3. There is region-wide interest in active community involvement in the revision of the Forest Plan and other Federal Land and Resource Management Plans as an outgrowth of the Montezuma County Federal Lands Program.

4. The Economic Development District is committed to housing the input/output economic model and maintaining it as a tool for local and regional decision making. The partnership between the District, the Office of Community services, and the Forest Service will be continued to fulfill this purpose.

The Federal/State/Local partnerships involved in the GIS project provides a model for extension to the other counties in Southwest Colorado as IRI work on the San Juan Forest moves eastward. The I-O model is flexible enough to evaluate the unique economic characteristics of each of the five counties individually and to provide a basis for regional economic analysis (See Figure 5, Future Generation component). These tools will be useful both in evaluating and pursuing economic diversification initiatives and in engaging important policy planning activities such as the Forest Plan Amendment. The development of these analytical tools will also strengthen the partnerships that are essential to tangibly improving economic and ecological sustainability.

Local, state and federal partnerships that address economic and ecological sustainability issues are evolving at the Valley, County, and Regional level in Southwest Colorado. The emerging benefits of these partnerships are: 1) improved capability for analysis, consensus building, and the development of action strategies that are focused in the community and on the land; 2) added capability to use differing capacities of the partners to combine technical analysis and broad based public involvement in a productive decision making process; and 3) the emergence of understandings and strategies that reduce the polarization of Traditional West and New West perspectives by creating common goals for economic and ecological sustainability.

SUMMARY AND CONCLUSIONS

Sustainable economic development is addressed in this paper in the context of leadership, cooperation, land stewardship and ecosystem management, financial efficiency, future generations, and development strategies. Leadership must be local, forward-looking, and take an ownership of strategies and projects. A wide variety of governmental and private groups must cooperate to provide for the necessary pooling of resources and the establishment of workable partnerships. Sustainable development depends on a land stewardship ethic which places paramount importance on the protection and maintenance of ecosystem integrity and stability. The financial efficiency of each strategy must consider how the costs and benefits are spread among the various groups and individuals. For economic development projects to be sustainable, they must consider potential impacts on future generations, such as how projects will affect ecosystems and the natural and financial assets available to the community in the future. These five components must interact successfully to design and carry out the sixth component: development strategies which are economically, socially, and environmentally sustainable.

Local, State, and Federal partnerships that address economic and ecological sustainability are evolving at the valley, county, and regional level in Southwest Colorado. These partnerships have provided for improved consensus building (for reducing the polarization of Traditional West and New West Perspectives, in part), ecological and economic analysis capabilities, and the development of action strategies that have a sound ecological and economic basis. Illustrative of these partnerships is the Federal Lands Program which the Montezuma County Commissioners took a leadership role in establishing. From this program a thinning project in the Second Growth Ponderosa Pine Zone was identified which illustrates how the ecology of the area and local business were jointly considered in a process of long-term sustainable economic development.

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The Southwestern Region's Strategy for Ecology Based Multiple Use Management

Cathy Dahms[1]

Abstract — On June 4, the Chief of the Forest Service committed the National Forests and Grasslands to taking an ecological approach to multiple-use management. This approach blends the needs of people and the physical environment in such a way as to achieve diverse, healthy, productive, and sustainable ecosystems. The Southwestern Region and the Rocky Mountain Forest and Range Experiment Station jointly developed an overall umbrella strategy document to guide the 11 National Forests and three National Grasslands of the Region in the implementation of ecosystem management. The strategy recognized that ecosystem management is not a new philosophy, but an evolution blending the principles and philosophies of multiple-use management though sustained yield and the Forest Service's New Perspectives program so that sound ecological principles are applied to all of our management activities. Shortly after the Region published its umbrella strategy, the Chief requested that each Region prepare a strategy structured around ten elements. This paper discusses the process we used to develop our basic framework for action as well as what specifically needed to be done to implement ecosystem management over the next five years.

On June 4, 1992, Forest Service Chief F. Dale Robertson committed the National Forests and Grasslands to ecosystem management. The Forest Service has defined ecosystem management as using an ecological approach to achieve the multiple-use management of National Forests and Grasslands by blending the needs of people and environmental values in such a way that National Forests and Grasslands represent diverse, healthy, productive, and sustainable ecosystems. Sustainable ecosystems are not only those that provide for the health and resilience of ecological systems and processes, but also provide for their livelihoods, outdoor recreation opportunities, and inspirational experiences, as well as sustaining economic prosperity.

In implementing ecosystem management, the focus will be on desired present and future conditions of the land and its human communities at multiple scales, always striving to maintain a balance between sustaining the resource itself (diversity, health, and productivity), lifestyle goals, and economic goals. If the desired conditions for these three areas are represented as circles, the goal of ecosystem management for the overall landscape would be somewhere within the intersection of the three circles (fig. 1). While striving to meet this generation's resource needs, we must be careful not to make any irretrievable resource decisions that would limit the ability of future generations to also meet their needs.

The key difference between ecosystem management and resource management of the past is that under ecosystem management, we look at the whole picture over space and time, while in the past, we tended to examine each resource separately and within units of land at the stand level. Also, ecosystems do not fall conveniently into our administrative, ownership, and jurisdictional boundaries, and frequently cross ownership boundaries. This calls for greater cooperation and coordination of goals and planning efforts with the landowners involved.

In addition, we recognize that ecosystems occur at different geographic scales. At the Region level, represented by U.S. map scales of 1:30 million to 1:7.5 million, broad analysis and modeling would occur. Landscape level analysis at 1:100,000 to 1:24,000 would most likely occur at the Forest planning level, while planning for ecological land units at the 1:24,000 scale would occur during project planning. Because ecosystems occur at different scales, we are faced with the challenge of considering the effects of our

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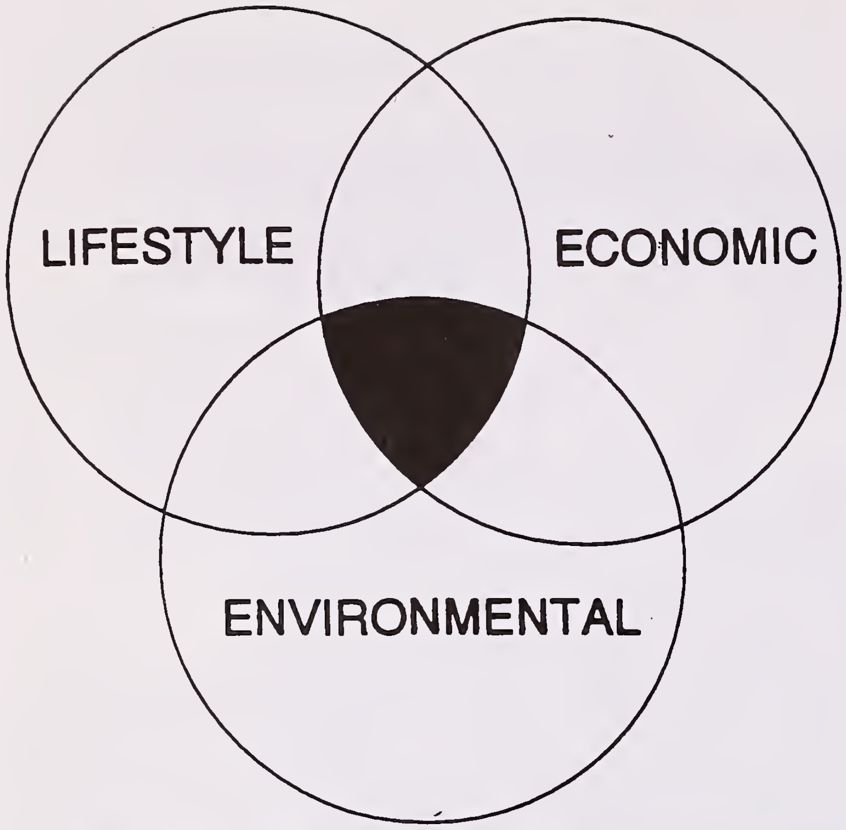

Figure 1. — The goal of ecosystem management.

proposed actions at several geographic scales as well as through time. When planning at the local or landscape level, we must recognize that our choices also affect the continental and global economy and environment. As a rule of thumb, we need to consider effects of proposed actions at least at one scale larger and one scale smaller than the scale we are working with, and for a minimum of several decades into the future.

To meet this challenge, the Southwestern Region and the Rocky Mountain Forest and Range Experiment Station jointly developed an umbrella strategy to guide the 11 National Forests and three National Grasslands of the Southwestern Region in the implementation of ecosystem management. The strategy examined where we are today and where we want to be in the future. Some of the key goals in our vision for the future are:

1. To have forest land and resource management plans that reflect programs and methods that are socially responsible, scientifically sound and, at broad scale land areas, are managed within long-term ecosystem capabilities or sustainability.

2. To develop a desired future condition (DFC) integrating the needs of people, land, and resources and is both site and landscape sensitive as the starting point for all projects. Cumulative effects are assessed through time and space. The goal of planning and implementation is to progress toward the desired future condition. Monitoring and evaluation are systematically carried out to determine effectiveness and validity of plans and practices and the results incorporated into forest and project level plans.

3. To approach land management from a holistic perspective, rather than for single resources.

4. To have an interactive program explaining the workings of southwestern ecosystems available to Forest Service employees and interested outside parties.

5. To have integrated resource inventories and analytical techniques in place that are cost effective to deal with the spatial and temporal aspects of ecosystem functioning at the landscape level.

6. To focus as much as possible on managing ecosystems rather than managing individual species.

Our next step was to expand our vision into a strategy document. In the development of our strategy, we actively solicited the input of the public, Forest Service Research, and employees at all levels of the Region. Ten elements formed the backbone of the strategy: public involvement, conservation partnerships, demonstration projects, improving our ties with scientists, our forest and project planning process, monitoring, classification and integrated inventories, new technologies, staffing and training, and the evaluation of our progress and performance.

Three of these elements (public involvement, partnerships, and ties with scientists) reflect the teamwork that is essential for the success of ecosystem management. More than ever before, we are committed to public involvement and need to solicit and incorporate people's views into our management decisions. As a part of our strategy, the Region developed public participation standards to provide consistency in our public participation process. Coupled with public involvement, we must expand our partnerships with agencies, organizations, individuals, and anyone else who has a shared interest in the management of the National Forests and Grasslands. Our strategy encourages partnerships at all levels - not only do we need to work with the local communities to help them achieve their long-term social and economic objectives, but we also need to encourage partnerships at the forest and regional level to coordinate our management of regional, national, and even international ecological systems such as the Colorado-Rio Grande Rivers or the Chihauhan Desert. The element of stronger ties with the scientific community is also a critical element, to make sure our decisions reflect the best science available. One of the ways we are forging stronger partnerships between the Region, Station, publics, and other scientists is by holding joint seminars, conferences, and

symposiums such as the one today. We have also formed a scientific study team to refine our understanding of ecosystem processes and the acceptable range of such processes in terms of sustainability at different scales.

For the next two years, the Region will have demonstration projects at each Forest for interpretation, professional development training and conservation education on ecosystem management. To incorporate ecosystem management in our forest and project planning process, our key strategy will be to develop regional policy and guidance to define the desired future condition concept, describe how planning areas and/or management areas will be based on ecosystem management within the landscape context, and to describe how effects on ecosystems and cumulative effects at larger scales will be analyzed. Since forest health is one of the key goals of ecosystem management, we also plan to capitalize on our Regional Initiatives that are focusing on restoring ecosystem health, ie. the Forest Health Restoration Initiative, the Pinon-Juniper Initiative, and the riparian issue. The Forest Health Initiative, for instance, is an initiative covering the complex ecosystems of ponderosa pine, mixed conifer, aspen, spruce-fir, woodland, chapparal, and riparian areas of the Southwest. The structure and composition of these ecosystems on National Forest Service lands have changed significantly since European settlement in response to both management activities (such as fire suppression and heavy grazing in the late 1800's) and climatic events such as periodic drought. In all forest types, stands are becoming much denser than had been recorded at the turn of the century. Openings in the forest have either decreased or been lost altogether. Mixed conifer forests have filled in meadows, and woodland species have moved into grasslands. Forest inventories show a rapid change in species composition. Since 1962, the acreage of mixed conifer on Forest Service lands has increased 81%, while the acreage of aspen has declined by almost one half. The ultimate result of these rapid changes has been a deterioration in forest health, with a decline in naturally occurring grasses and forbs, increased risk of high intensity wildfires, higher levels of insect and disease infestations, and a loss of diversity with a resultant decline in the quality of wildlife and fish habitat. The Initiative calls for an accelerated effort to restore overall forest health so that anticipated disturbance events such as drought, fire, or insect outbreaks fall within the ability of the various ecosystems to absorb and thereby maintain their biological integrity, and is an important component of our overall Regional strategy.

Monitoring and evaluation is another emphasis area. In addition to our traditional monitoring of the implementation of projects, we will need to identify elements needed to actually monitor ecosystems, and to monitor the achievement of our desired future conditions (DFC's), as well as the suitability of chosen DFC's as a portrayal of ecosystem sustainability. The Region-Station will be developing guidance in these areas.

Before we can effectively evaluate ecosystems at multiple spatial and temporal scales, we need to have the date in place and the analytical tools available to support ecosystem management. Integration of our inventories, classification, and data base systems are needed to provide a uniform framework for use in land and resource management planning and to develop an ecologically based information system--not only within the Region, but at the National level as well. Immediate needs in our Region are to complete our Terrestrial Ecosystem Survey for all Forests (half of the Forests have been completed so far) and to develop an integrated, uniform, existing vegetation information system across all functional areas. Continued work on a set of Regional standard terms and definitions is another strategy item. Geographic Information Systems (GIS) will be a critical tool to conduct spatial analyses to assist resource managers, and implementation of GIS technology, along with related technologies such as videography and remote sensing, are an important part of our Regional strategy.

To assist in the implementation of the Strategy, an Ecosystem Management Interdisciplinary Team (EM IDT) was chartered this year, with members from the Rocky Mountain Station, Regional resource staffs, the public affairs office, and the program and budget staff. To work on specific ecosystem management topics, task teams have been created. Some of the current task teams are the scientific study team, two teams to work on an integrated existing vegetation data base (a tabular team and a spatial team), a team to explore the data and analysis needed for the human dimension, a team to evaluate demonstration projects, a monitoring and evaluation team, and the Every Species Counts task force that is charting a desired course for threatened, endangered, and sensitive species. Proposals from the task teams are reviewed by the EM IDT--for the first time we have an organized interdisciplinary team of Region and Station employees from all functional areas to review recommendations and coordinate activities across the Region-Station. Right now, the EM IDT is working on developing an action plan focusing on key actions needed to implement the Strategy over the next two to three years.

The concept of taking an ecological approach to multiple-use management is not fully developed and is unevenly understood, internally and externally. We recognize that the strategy is not a static document, but will continue to grow and evolve over time as more information and experience are acquired regarding the implementation of ecological principles. Rather than trying to fit our strategy to our existing resources, we recognize the need to stretch beyond our resource limitations and invent new ways of achieving our goals. One of the challenges in our continued strategy development will be to provide the necessary guidance to land managers without suppressing the creativity and innovation so critical to the success of ecosystem management.

Accounting for Environmental Infrastructure in Sustainable Economic Development: A Conceptual Framework

Daniel W. McCollum[1], Gregory S. Alward[2], and Susan A. Winter[2]

INTRODUCTION AND PROBLEM STATEMENT

In his book, *Earth in the Balance*, Vice President Gore discusses an issue that has been raised by several others (e.g., El Serafy, 1991; Peskin, 1991; Hueting, 1991; Hannon, 1991; among others). The issue involves the structure of the National Income and Product Accounting system used in the United States and many other nations of the world. Indeed, the United Nations guidelines for the development of these economic "systems of national accounts" (SNA) are followed by virtually every nation in the world. The argument is that the SNA are deficient in the area of capital stocks and how some expenditures related to capital are included in Gross Domestic Product (GDP) while others are not. A prominent example of the deficiency is the treatment of "Natural Capital." The stock of natural capital includes natural resources—forests, watersheds, ecosystems, and the like—and the condition or quality of those resources—air quality, water quality, scenic beauty, etc. Such natural capital, like "manufactured capital," constitutes part of the national/regional/community wealth and makes real contributions to the economy, both directly as inputs to productive processes and indirectly as inputs to quality of life. In the context of national income accounting and structural modelling of national/regional/community economies, however, natural capital and expenditures related to it are excluded. That is, the SNA include only expenditures related to manufactured capital; "capital" in the SNA is limited to those forms of capital produced by industrial processes. The result is: (1) an incomplete picture of the economy, (2) misrepresentation of the amount and kinds of productive economic activity taking place in the economy, and (3) an inaccurate accounting and measurement of national income and wealth levels.

When expenditures are made related to buildings or machinery (known as investment), the effect on GDP is offset by the deterioration in condition (or decrease in productive capacity) of the asset that made the expenditures necessary (known as depreciation), both of which are included in the calculation of GDP. Expenditures related to natural capital, such as pollution control and abatement, are considered to reflect productive economic activity and are counted in GDP. Not counted in GDP, however, are the reasons those control and abatement expenditures are made. In effect, only one side of the balance sheet is being considered. Degradation of a natural capital stock is not conceptually different than depreciation of any other capital asset. Expenditures to maintain or upgrade the condition of the natural capital stock are not conceptually different than investment in any other capital asset. Therein lies the problem. While the stock and flow (changes in the condition of the stock, represented as depreciation and investment) of natural capital are not conceptually different than those of buildings, machinery, and other traditional capital assets, they are treated differently in the national income accounting framework resulting in an incomplete picture of the economic structure of the nation/region/community and incomplete measurement of the economic activity occurring in the nation/region/community, leading to an inaccurate estimation of national income and wealth.

One important implication of this deficiency in the SNA concerns sustainability (or the perception of sustainability) of resource uses. Decisions made regarding resource uses are based, in large part, on the income flows which those uses can generate. An incomplete accounting of the flows (i.e. investment and depreciation) affecting resource stocks leads to a distorted perception of the income generating capacity of the resource stocks.

Sustainability is a difficult concept which can carry unintended connotations. The term, as we use it, carries no implication of right or wrong, or good or bad. We ask

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whether a resource use or resource-based activity is sustainable only in the sense of asking: (1) Can we continue to use the resource as we are currently using the resource? and (2) How will our current use of the resources affect our future use of the resources? This concept of sustainability can be framed in economic terms. When considering an income stream resulting from use of a natural resource, the question to ask is: How much of the total revenue should be considered depreciation to reflect deterioration in the condition (or loss of productive capacity) of the natural resource and how much represents true net income? The resource use could be considered sustainable if a positive net income stream can be maintained without decreasing.

This concept of sustainability is actually rooted in traditional economic theory. Hicks defined income (in a dynamic theoretical context) as that which "one can consume during a week and still expect to be as well off at the end of the week as he was at the beginning" (Hicks 1946, p.172). Later on, Hicks discussed social income as "consumption plus capital accumulation" (1946, p.178). In the case of depreciation, of course, capital accumulation is negative.

A CONCEPTUAL FRAMEWORK IN WHICH TO VIEW THE PROBLEM

The problem discussed in the Introduction is more basic than counting some components of economic activity while not counting others. The problem stems from the way that economic structure is viewed and modelled. The measure of economic activity and wealth can be no better than the underlying model from which it is derived. As a result, it is not enough to "fix" the measures defined by the SNA by making adjustments here and there. What is needed is a revamping of the way wealth is defined and modelled. For that, the underlying framework, or view of the world, must be revised.

The framework presented here closely follows that laid out by Ekins, Hillman, and Hutchison (1992, pp. 52-61). That framework closely mirrors our own thinking and captures the essence of the literature discussed above. Rather than reinvent a framework, we will present a slightly modified version of theirs.

At least in modern times, it can be argued that man has consistently strived to accumulate wealth. Recognizing that wealth can have many facets, and that what is considered wealth may differ between individuals, we will consider wealth to be anything that makes us better off—either individually or collectively. The concept of wealth has both a stock component, which we refer to as capital, and a flow component, referred to as production. As production takes place some of the capital stock is consumed or its quality deteriorates; that is, capital depreciates. To maintain production that capital must be replaced. Hence, some of the production must be diverted to replace or offset depreciated capital. Replacing consumed capital, along with augmenting or enhancing the capital stock is referred to as investment; more will be said about investment later. That part of production remaining after capital depreciation is accounted for is income—in line with the Hicksian concept of income discussed above. With that brief description of the plight of man as a context, let us consider how wealth has been created, maintained, and measured in the context of economic models.

The traditional approach to macroeconomic modelling of structure and production is to consider three factors of production—land, labor, and capital. That framework is

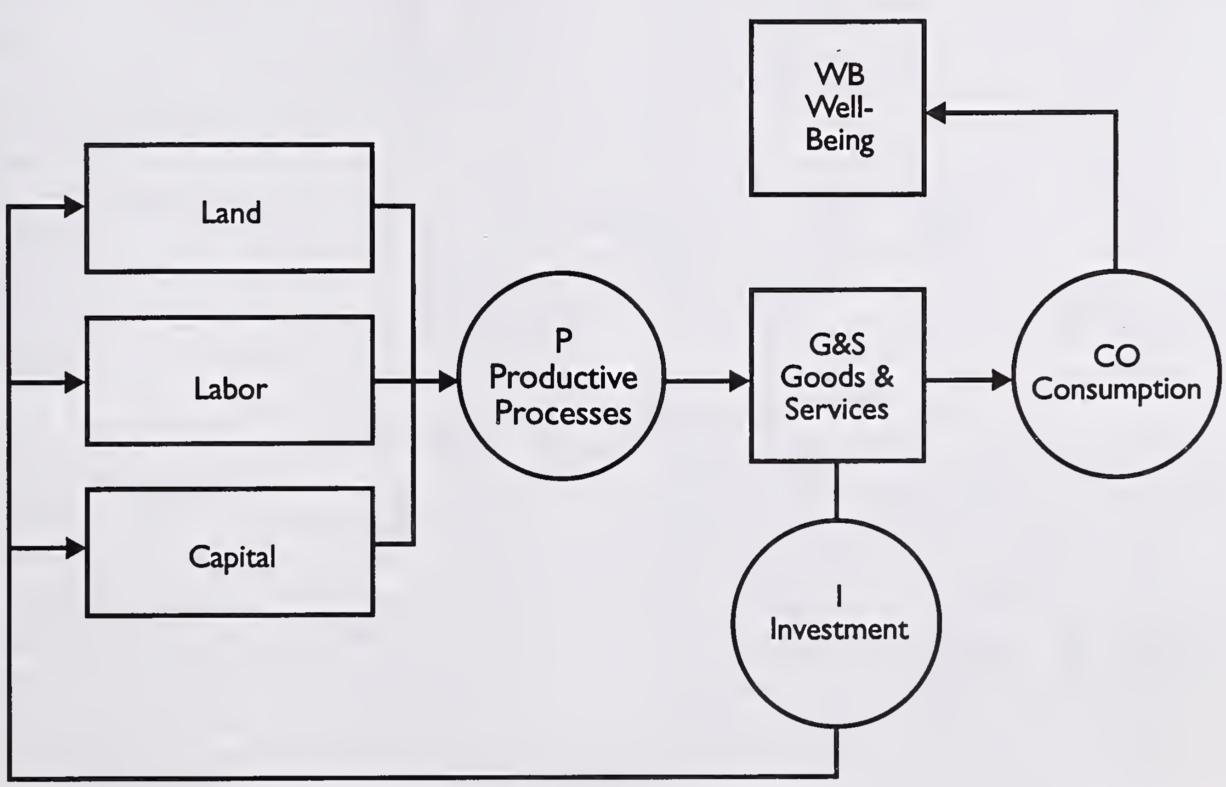

Figure 1. — The Traditional Model (adapted from Ekins, et al. 1992).

illustrated in Figure 1. Land, labor, and capital are combined to produce goods and services. Some of the goods and services go to people's consumption which produces utility or well-being. The balance go to investment to sustain and support workers, and to replenish capital consumed in production. To the extent that investment exceeds depreciation, the capital stock increases allowing future production to increase. The trend over time has been to substitute land and capital for labor, thereby raising productivity which is measured as production per unit of labor. Land was generally regarded as a fixed, locational factor and, consequently, not paid a lot of attention in modelling. As a result, capital (which was viewed as machinery and equipment) was the main focus of the model. Increased income and wealth were seen to result from increased and improved capital.

At the same time, only marketed goods got counted in GDP which has been used to measure production in an economy and indicate the level of wealth in society. The production process has many byproducts. To the extent that the byproducts affected marketed goods, as in the case of capital depreciation or consumption goods, they got counted in the computation of production and wealth. To the extent that byproducts of production did not show up in marketed commodities, as in the case of effects on environmental amenities, those byproducts did not get tallied. Under such circumstances it is not difficult to see how an economy could appear to be increasing in wealth, as measured by GDP, yet suffering considerable decline in human well-being resulting from environmental degradation.

The approach suggested here is to reframe the conception of capital. Capital is broadened to include all factors of production. **Manufactured capital** (MC) consists of the tools, equipment, machinery, buildings, etc. that make up the traditional concept of capital. To that are added several other categories of capital. **Human capital** (HC) encompasses the labor factor of the traditional model, but the concept is considerably broader than a worker performing a specific task in a production process. Human capital is composed of health, knowledge and skills, and motivation (Ekins et al. 1992). All contribute to the productivity of workers, and thereby, to income and wealth. **Social and organizational capital** (SOC) is composed of the economic and social structures and institutions within which productive activity and all associated activities take place. The legal structure and organized markets fit into social and organizational capital, as do trade associations, cooperatives, and community level nongovernmental organizations. Organizations can affect efficiency and creativity and, thus, contribute to the productive process and generation of income and wealth. They can also be enhanced (or invested in) and they can be degraded (or depreciated); hence their designation as capital. **Natural (or ecological) capital** (NC) expands on the land factor of the traditional model, and is composed of natural resources—both renewable and nonrenewable—below, on, and above the earth. That such resources contribute to productive activity has never been doubted. Many contributions of natural capital are documented, measured, and included in the summation of productive activity for GDP—output from timber harvesting,

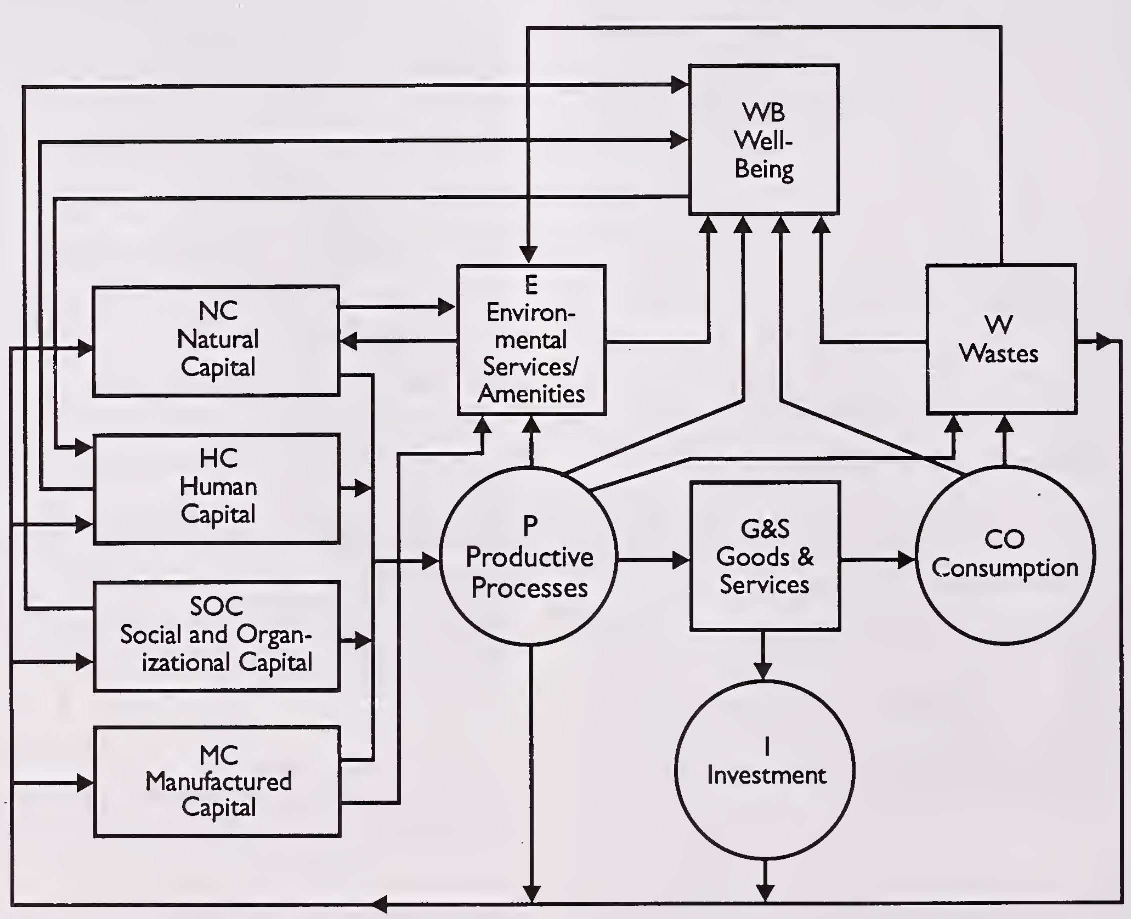

Figure 2. — The Four Capital Model (adapted from Ekins, et al. 1992).

mineral production, etc. Other contributions—like environmental amenities and environmental quality—though often recognized as positive factors and sometimes recognized as having effects on productive activities, have not been explicitly measured and incorporated in the summation of GDP.

Figure 2 diagrammatically presents the "four capital" conceptual framework in which we consider environmental infrastructure and its role in sustainable economic development. The four categories of capital described above are represented along with outputs derived from the capital factors: productive processes (P), environmental goods/services/amenities (E), goods and services (G&S), consumption (CO), wastes (W), and well-being (WB). Flows between the components of capital and the outputs are shown by arrows. We will illustrate the flows between the various types of capital and the outputs and services derived from them. Many examples exist besides those we specifically mention.

The production process (P) is the intermediary through which various types of capital are combined to produce outputs. Buildings and machinery (MC) provide the production lines for manufacturing a variety of products, for example. Human capital (HC) provides many types of labor, and natural capital (NC) provides many inputs to productive processes like wood for construction, coal and oil for energy to run the production lines, etc. The legal structure providing the framework for contracts and other relationships between producers and other producers, and producers and consumers, is an example of the social and organizational capital (SOC) contribution to production. Production produces goods and services (G&S) which go to consumption (CO) and investment (I). Production directly produces waste products (W) and more waste products are generated by consumption. Production has an effect on environmental goods/services/amenities (E), both positive (like fish habitat provided by a pond/lake created after a gravel pit ceases operation) and negative (noise, visual intrusion by factories, etc.). Productive processes contribute to well-being (WB) by providing positive work experiences for people and contributing to working relationships. Finally, production has effects on the various types of capital—MC depreciates, NC deteriorates or is used up or harvested, HC resources might be enhanced or depreciated by productive work, etc.

Manufactured capital can have an effect on environmental goods/services/amenities (E) through such things as buildings and the built environment that add to (or detract from) scenic beauty. Natural capital has an obvious effect on E, since in many cases environmental amenities are made up of the resources comprising the stock of natural capital. Besides those, such things as the protective ozone layer, part of the natural capital stock, provide environmental services. The environment has an effect on natural capital as well. Such things as desertification and sedimentation are examples of environmental attributes that have a feedback effect on the stock of natural capital. Environmental goods/services/amenities have an effect on well-being through satisfaction derived from wilderness scenery or outdoor recreation opportunities. Finally, wastes (W), created by productive activities and consumption, affect E through such things as global warming, ozone depletion, etc. Besides their effect on E, wastes affect well-being (through litter or pollution effects on health) and the various types of capital. Health related effects of pollution can affect human capital and the productivity of labor, acid rain caused by sulfur emissions can affect natural capital—reduced water quality affecting fish habitat for example—and manufactured capital—corrosive effects on equipment and structures.

Consumption, besides producing waste products, contributes to well-being through the utility derived from using and consuming various goods and services—the pleasure of owning a red sports car, etc. Well-being is affected by social and organizational capital due to the relationships embodied in SOC through community and other social interactions. There is a two-way effect between well-being and human capital. A healthy and motivated person (high levels of HC) may be more likely to feel happy and experience generally high levels of well-being. People with high degrees of well-being may be more likely to remain healthy and motivated and to enhance their knowledge and skills.

Goods and services that do not go to consumption go to investment (I) which affects all types of capital. Investment in manufactured capital produces new and better machines and technology to go into productive activities. Investment in MC may also go to produce cleaner and more efficient productive processes that, in turn, rebuild or enhance the stock of natural capital. There can also be direct investment in NC by such things as reforestation projects or pollution abatement activities. Human capital can be enhanced through education or training to augment or strengthen job skills and productivity. It can also be enhanced through public health programs and the like. Social and organizational capital can be enhanced, for example, by investment in efforts to promote efficiency by streamlining a bureaucracy or by working to eliminate "turf battles" between parallel agencies.

The four capital framework in Figure 2 illustrates how complex the workings of the economy are and how everything affects and is affected by everything else. The interactions and feedbacks that must be considered and accounted for by a structural model of the economy, if it is to provide a true picture of the economy, are much more complex than could be captured by the traditional land-labor-capital framework shown in Figure 1. In the next

two sections, we outline, first, an accounting structure to incorporate information about the environmental infrastructure; then, a research project to begin to make this conceptual framework operational and applicable by planners and policy makers.

Accounting For Environmental Infrastructure

How can systems of national accounts (SNA) incorporate the revised macroeconomic model described above and overcome the omission of natural capital? The solution proposed here is to extend the framework of the SNA, in order to benefit from the years of debate and experience gained in national economic accounting, by including information about the environmental infrastructure that comprises natural or ecological capital. The stock, flow, and state characteristics of natural capital can be captured in an accounting framework that extends the rectangular double-entry accounting system used in SNA and, in particular, social accounting systems. While the experience of economics has guided this approach to *environmental infrastructure accounting*, the consequences of the laws of thermodynamics can be incorporated as constraints to create a more comprehensive and less arbitrary accounting system that simultaneously meets the needs of ecologists and economists.

Ecologists have been accounting for material and energy flows for a long time. In the past each type of material (i.e., nitrogen) or energy was accounted for independently of all the rest. For *environmental infrastructure accounting*, interconnections between all the material and energy (and service) flows must be included in the general accounting framework. That framework must allow quantified connections between organisms and their abiotic environment to be placed and balanced, without ambiguity, omission or double counting exchanges, at any scale necessary (Hannon, 1991). Connecting elements in an accounting system makes it possible to trace and quantify indirect causes of change. The number and complexity of indirect linkages, however, overwhelms perceptual capacities so that systematic analytical techniques must be relied upon. Of course, the question of indirect effects is hardly limited to ecology. It is a significant issue in economics as well. The principal advantage of the accounting framework is that it allows the material, energy, and service flows between all parts of an economy and an ecosystem to be systematically identified and placed in a common framework.

The accounting framework proposed here closely follows the work of Hannon (1991). To account for environmental infrastructure—natural capital—one must begin with a system definition. The delimitation of the system is strictly at the discretion of the observer, i.e., system boundaries and internal elements may be chosen at will. But not all choices are equally good. Ideally, physical boundaries are chosen to minimize the amount and diversity of exchanges across them so that exogenous transfers can be more easily monitored.

Figure 3 summarizes the economic SNA augmented to include environmental infrastructure, given an ecosystem boundary definition. Six components are illustrated that are critical to the identification of environmental infrastructure: 1) nonproduced inputs; 2) net outputs; 3) product use record; 4) product production record; 5) total output; and 6) waste heat flows. For economic flows, *nonproduced inputs* are imports and primary factor inputs. For the environmental infrastructure components, one must distinguish between imported products made within the defined ecosystem and imports of special products not made within the system. Nonproduced inputs are usually thought of as constraints or

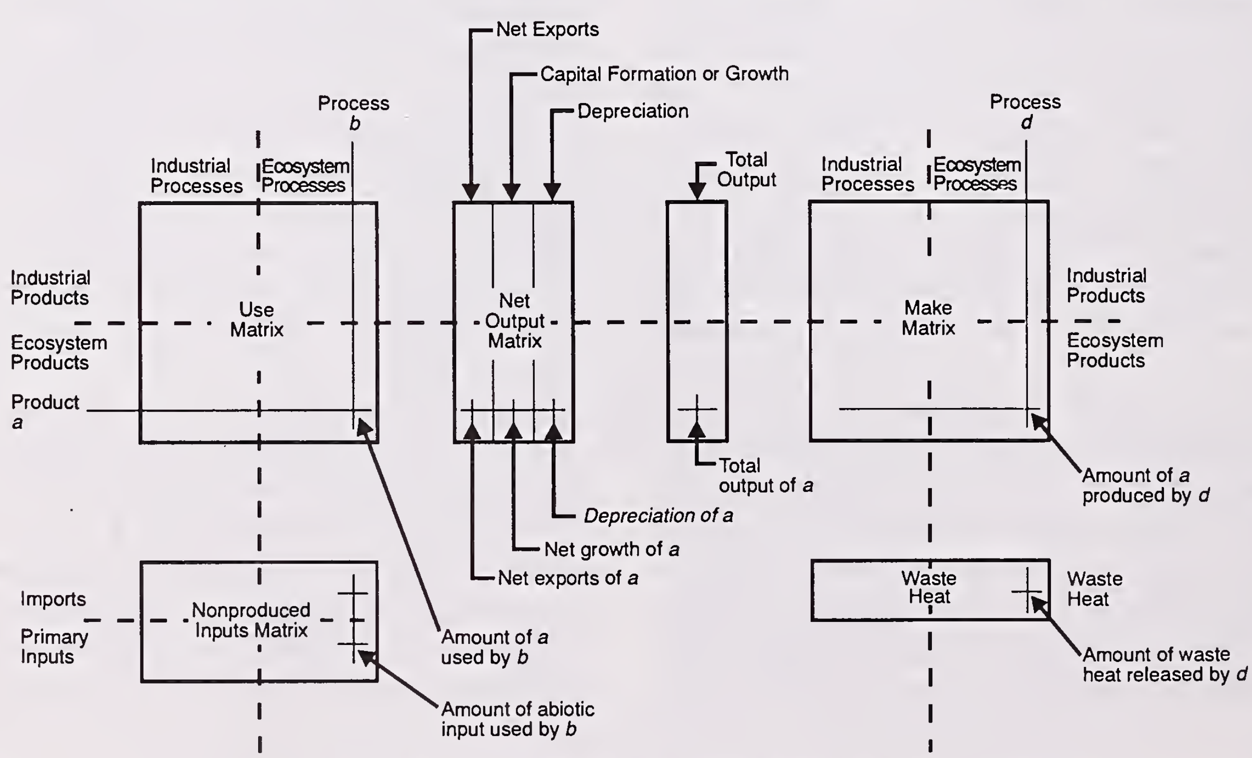

Figure 3. — SNA Augmented for Environmental Infrastructure.

growth-limiting factors for the system's activity level. An example of a nonproduced input is solar radiation. The *net output* flows are connections from the defined ecosystem (or economy) across the system boundary to itself at a future time and/or to other ecosystems. There are three kinds of net output flows which must be accommodated in the accounting system: (1) Imports and exports of products made and/or used by the processes in the defined system. (2) Changes in storage levels (or inventories) of particular products which occur during the designated time period. Since a static picture of the system is assumed, changes in stocks must be included explicitly as flows, and might be thought of as flows across the time boundary of the chosen period. (3) Changes in stocks due to the natural decay and stock replacement inherent in all products of the system as required by the second law of thermodynamics (this is analogous to depreciation and investment). The *product use record* (or "use matrix") indicates which products each economic or ecological process uses. Referring to Figure 3, each row of the use matrix indicates the amount of product represented by that row used by each of the industrial or ecological processes represented by columns in the matrix. The row total, therefore, is equal to the total amount of that product used in the system. (Columns in the use matrix represent the array of products used as inputs by each industrial or ecological process in the system.) Conversely, the *product production record* (or "make matrix") indicates which products are made by each process. Rows in the make matrix are the amount of product produced by each industrial/ecological process represented as columns. Hence, row totals in the make matrix are the total amount of that product produced in the system. That *total output flow* can also be expressed as the sum of entries in a row of the use matrix and the corresponding row of the net output matrix. (Columns in the make matrix represent the output array of each industrial/ecological process.) Finally, *waste heat flow* is given off by each process. This heat is considered lost to the system due to its lack of utility to any of the other organisms in the system.

The framework shown in Figure 3 is similar to the rectangular double entry accounting format of input-output analysis and SNA. It can provide more robust information about natural capital within the accounting framework of the SNA. This can allow extant data bases, gathered for unrelated purposes, to be incorporated into the same framework as current data. Together, these data can reside in a framework that provides the format for evaluating ecosystem function. Models can be based on the accounting system (such as input-output models) and could be used to estimate the flow and stock changes resulting from the introduction of new species or certain toxicants, for example, as well as economic policy changes. The use of an environmental infrastructure accounting system could help assure ecosystem managers that a research effort defined the system boundary (in space and time); that materials, energy and service flows for each compartment of the ecosystem under study were subjected to accounting balances; that the connection of any particular species to the ecosystem could be quantified; and that data from different sources and time periods can be compiled into a framework which would have continued utility.

APPLYING THE CONCEPTUAL FRAMEWORK

The problem outlined in the Introduction occurs in most nations. The way in which the problem manifests itself, however, and the implications drawn from a solution to the problem, may be somewhat different in a highly developed nation—where "progress" can be thought of in terms of maintaining a standard of living and refining or fine-tuning an economic structure that is already established and in place—than in a developing nation—where "progress" is more firmly couched in terms of raising the standard of living and developing and building an economic structure to accomplish that. To properly address the problem described in the Introduction and develop a socioenvironmental based capital accounting system, one should, therefore, consider both the context of a developed nation and that of a developing one. The United States and Mexico are a pair of nations that present an inviting context for such a research endeavor. While the United States is seeking economic diversity in some areas to stabilize communities, the basic context is that of a developed nation. Mexico, on the other hand, is a rapidly developing nation seeking economic development to raise the basic standard of living of its people.

The project is composed of three stages. In the first stage, basic traditional input-output models will be constructed for a given region in Mexico and a roughly corresponding one in the United States. The focus of the input-output models will be on the production process and inter-relationships between industrial sectors in the regional economy—the basic flow of economic transactions. The premise of the basic input-output structure is that income and other flows originate from capital, viewed in the traditional sense as the land, buildings, and machinery used in production processes. This stage of the project will provide an empirical and quantitative picture of the basic economic structure of the regions by answering the questions: "What is produced in the region (in terms of marketed goods and services)?;" "Where do inputs to the production processes in each industrial sector come from?;" and "Where do outputs of the production processes in each industrial sector go?"

The second stage of the project will expand those basic models using a "Social Accounting Framework" to include consumers, government, and other institutions present in the regional economy, but who are not part of the production

process per se. Including these other sectors in the model provides a more complete picture of the economic inter-relationships and activity in the region. Whereas the basic level input-output structure in Stage 1 focuses on the traditional concept of capital and uses that concept as the stock from which flows through the regional economy originate, the social accounting framework adds human capital and social and organizational capital to the concept of capital stocks from which flows originate. This part of the project will answer the question: "To whom does income resulting from production processes in the region accrue?"

The third stage of the project represents a generalization and expansion of the notion of the social accounting framework by considering the capital stock in an ecological context. In a broader context, beyond traditional capital stocks, human capital, and social and organizational capital, it is reasonable to include a wide variety of natural resources in the capital stock. As illustrated in Figure 2, the availability and condition of natural capital affects production processes every bit as much as the availability and condition of machinery on a production line. Because industrial producers do not pay for natural capital in the same way they pay to buy and maintain machinery or buildings, however, natural capital is not looked at in the same light as buildings and machinery. For example, depreciation of natural capital—degradation of a forest ecosystem or deterioration of air or water quality—is not explicitly considered in production decisions. In economic terms, the full cost of production is not being considered and borne by the producers and users of the good, and the true and complete value of the region's capital stock is not being recognized. To reflect the complete value of the region's capital stock, natural capital must enter the structural model of the economy, and depreciation and investment in the natural capital stock must be considered along with that related to buildings and machinery. By leaving natural capital out of the structural model of the economy, one is left with an incomplete picture of the regional economy.

Objectives of the third stage of the project, therefore, include: (1) identifying the existing natural capital stock of the region and its current condition; (2) determining the trend of the condition (or the flow) of the natural capital stock over time; (3) developing a theoretically appropriate means of including natural capital stocks in the structural model of the regional economy (such as with the accounting system described in the previous section); and (4) collecting the necessary data to empirically implement the inclusion of natural capital stocks in the structural model of the economy.

Stage 3 is where the issue of sustainable resource use could enter the picture. As discussed in the Introduction, resource sustainability can be defined in terms of the income flow produced by a particular resource use. Including natural capital in the structural economic model allows one to empirically analyze such income flows while accounting for changes in the condition of the resource. Specific research questions would include: (1) Are current uses of natural capital in the region compatible and sustainable with respect to the existing natural capital stock and its current flows? (2) Are currently proposed or anticipated changes in the uses of natural capital compatible and sustainable with respect to the existing natural capital stock and its current flows? (3) What potential might the region's natural capital stock offer in terms of opportunities for sustainable economic diversification and development? A research question posed of the system used to classify land or other resources for a variety of uses is: How well are changes in the landscape and resource base reflected by changes in the classification system?

Sustainability also raises issues of income and wealth distribution, intergenerational equity, and revenue capture, among others, that are beyond the scope of this paper. Toman (1992) discusses the difficulty in defining and achieving sustainability. Loomis and Thomas (1992) discuss the issue of revenue capture for environmental assets.

Uses and Implications

Most importantly, the project described will be a first step toward including the broad scope of capital described in the conceptual framework in a structural model of an economy. Being able to include the full range of capital in the structural model implies such capital stocks, and the flows related to them, will be quantifiable in terms of national income account type measures of wealth and income. Having the capability to measure the broader concept of wealth discussed in this paper will allow more accurate gauges of the progress made by developing nations and the health of developed nations.

Second, the project will allow analysts to more thoroughly evaluate effects of policy alternatives. The basic models estimated for Stage 1 and the expanded models estimated for Stage 2 are the tools for economic impact analysis. By measuring market transactions related to a particular good, resource, or activity, and tracking those expenditures as they move through the economy, economic impact analysis answers the questions: "How much money does a particular good, resource, or activity bring into the economy?", "Where does the money come from?", and "Where does the money go?" Addition of the social accounting framework in Stage 2 enables the question "To whom does the money accrue?" to be answered. By looking at sectors and industries where economic activity occurs related to a particular policy or management action, and the groups to whom income accrues as a result of that economic activity, analysts can measure which groups gain and which groups lose as a result of alternative policy or development activities. Applied to specific industries/activities —recreation and tourism for example—such an economic impact analysis would provide information on the importance of those activities in the regional economy in terms of sales and numbers of jobs in the region supported by recreation and tourism related activities, and the potential economic effect of increased recreation and tourism activity in the region. An

economic impact analysis will show where leakages of money out of the economy occur and which sectors of the economy contain the fewest leakages. Such information holds implications for economic development, such as where development might be encouraged so as to maximize the effect on the regional economy, or where development might be used to stop leakages out of the economy so as to increase the impact of incoming money.

Addition of the ecological accounting framework in Stage 3 allows sustainability to enter the analysis. Not only could analysts consider the traditional notion of economic impact of a policy or management alternative, but now an economic expression of ecological impact could be considered as well.

CAVEATS

While the framework discussed above "looks good on paper," it is of little use if it cannot be applied and adopted in a policy context. The project outlined above is a step toward making the conceptual framework applicable in a policy context, but making the framework policy applicable is only one component of a solution to the larger problem of sustainable resource use. That problem is multi-faceted and any solution will need to be likewise multi-faceted. To illustrate, consider the passage from Vosti (1993) concerning a resident of the Brazilian Amazon:

> *Jose doesn't have a perverse desire to denude the world of rain forests, nor does he love the toil, danger, or high cost associated with felling massive trees with fairly rudimentary tools. Jose wants to guarantee food on the table and a livelihood for his family of six living in one of the least hospitable places in the world. It is not an easy task. Jose has been dealt a bad hand in the social reshuffling of natural resources. But by hook or by crook, he gained access to trees (lots of them), poor soils, seasonally torrential rains, malaria (lots of it), and isolation—all of which combine all too frequently to generate hunger.*
>
> *Jose is not completely ignorant about the valuable hardwoods or rich biodiversity contained in the remaining forested portion of his lot that persuades him to pick up his saw. No, he has heard that his private forest contains strange and potentially useful trees and plants. But he is a newcomer to the area, and there is no one to tell him which plants are possibly valuable, and virtually no scope for turning these trees or special plants into cash or food—which is what his patch of forest must generate in order to sustain his family.*
>
> *Jose is not shortsighted either. He does look to the future. He knows his annual cropping patterns will deplete soil nutrients. But his view of the future is through the window of the present—action taken today may bring doom tomorrow, but failure to undertake today's action will almost certainly bring today's doom.*
>
> *Jose knows that some agricultural strategies require much less forest conversion than others. He knows that horticultural pursuits require the least amount of cleared land, and cattle require about one hectare of cleared forest per head. But poor market links, virtually nonexistent banking systems, and ever-increasing shortages of agricultural labor (including on-farm labor as Jose's family grows older and off-farm wage labor as urbanization trends accelerate in these hinterland areas) force his hand. He must diversify his production activities in ways that reduce risk and can be done with available labor—the trend towards increased cattle production is clear and rational. (Vosti 1993, p.24)*

The story is from Brazil, but the dilemma is repeated in many parts of the developing world. "Given his ecosystem, his aspirations and the constraints he faces, Jose has no choice but to deforest small plots of his land. It is legal to do so on up to 50 percent of his land... Once the land is exhausted—often after a few years—he needs to deforest more. His choices are limited; his future is bleak. He begins to saw the next tree" (Vosti 1993, p.25).

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Collisions of Alternative Cultural Visions of Forest Ecosystem Management

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Abstract — There is a strong body of legal protection for the forest resource in both Mexico and the United States, promulgated with the goal of sustaining both the natural resource and the communities that depend on it economically. It is clear, however, that these regulations and controls have met with less than complete success. Examples include the endless litigation over forest plans in the US and the continuing deforestation of the tropics in Mexico. An examination of the history of these regulations suggests that a major pitfall in their application has been the dominance of only one governmental or scientific vision in their development. The purpose of this paper is to examine the repercussions of a "mono-cultural" view of forest ecosystem management, and to discuss the potential benefits of utilizing a multicultural vision in management decisions.

INTRODUCTION

Recently, the management of forest resources has attracted unprecedented attention all over the world. The precarious state of forest health is giving rise to more widespread concern than at any other time in the history of civilization. Several conditions are driving this global concern: the long history of adverse environmental effects caused by human activities, conflicting views of how people perceive and value their relationships with natural ecosystems, and the increasing damage to regional and global environments by human activity resulting in global change. Rising populations, economic growth, improvements in education and communication technologies, increased trade liberalization among nations, and growing democratization resulting in increased public participation in ecosystem management decisions, are in many ways compounding the magnitude and complexity of the challenges governments face when legislating and regulating the management of forests.

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In response to these changes in society, governments are designing and implementing legislation directed toward promoting forest management with increased environmental sensitivity. In this process, it is expected that traditional utilitarian timber management models will be replaced by new approaches that recognize the ecological nature of forests and the alternative cultural views of people. The ecosystem approach to forest resource management provides flexibility and wholeness for integrating these perspectives. Within this context, the ecosystem approach can be viewed as a means for achieving the goals of sustainability, productivity, and social equity in any natural resource management plan.

The lack of a holistic approach to natural resource management has been a well documented characteristic of human behavior. This particular aspect of human interaction with natural systems has been common among cultures for generations. In fact, the socio-history of ancient agricultural civilizations on both the Old and New Continents provides to modern society unique examples of land abuses that contributed to or precipitated their breakdown. In this paper, an historical analysis of land use patterns and management practices of ancient civilizations is used to help identify and understand how cultural collisions resulting from centralized government policies have impacted forest ecosystems and influenced the controversial issues society faces today. Case studies of land use management from ancient cultures of

different regions of the world are used to provide a foundation for the discussions in this paper. In addition, the authors address the fundamental question of integrating a multicultural vision into the decision making process in forest ecosystem management.

HUNTERS AND GATHERERS

A basic understanding of Man and his development is fundamental to the analysis of man's relations to natural ecosystems (Winters 1974). Early humans (*Homo erectus*) are believed to have appeared at the end of the last glacial periods, some 500 to 700 thousand years ago. By this time, man's skills, tools, and weapons were still too primitive to produce significant impacts on the environment. Many believe that the first widespread impact of humans on the natural environment occurred when they learned to control and use fire. It is not known when this happened precisely, but there are indications in China that this may have occurred 300 to 400 thousand years ago.

Human settlement of temperate latitudes really took hold during the Great Interglacial period (400 to 200 thousand years ago) as small bands of hunters exploited the rich game populations of European river valleys. Fires caused by these bands shaped the natural landscape and dense forests were converted to savanna-forests and ultimately to grasslands. Other than the impact of broadcast burning, and despite fairly sophisticated social institutions and superior technology, early humans did not greatly disturb the ecological balance. They were an integral part of the natural environment with large home territories and a population regulated by food supply. Food and shelter needs were easily met by these small bands of hunter-gatherers without adversely impacting ecosystem carrying capacity.

With the advent of *Homo sapiens* came a radical change. This new species of man began to exploit territories never inhabited before. Still hunter-gatherers, they began to exploit the western Russian plains, the Siberian tundra, and the Far East. Japan was already occupied by the late Pleistocene, and Australia perhaps more than 30,000 years ago. The N. American continent was also settled by late Pleistocene hunters. Small bands of hunter-gatherers from Siberia and Northeast Asia appear to have been the first humans to reach the New World. The exact date of this migration is still unknown, but it may have occurred during the last glaciation (27 to 8 thousand years ago). During this time period, many big game species became extinct. Nowhere were the extinctions so drastic as in the New World. It has been estimated that about three quarters of the mammalian genera there abruptly disappeared at the end of the Pleistocene. In addition to climatic changes, it has been widely hypothesized that hunters were the final variable which accelerated most of these extinctions and might even have caused the loss of more species than might otherwise have occurred.

Hunting and gathering were critical to the survival of early humans. To this end, they developed complex toolkits and sophisticated techniques. Initially, humanity lived in ecological balance with the natural environment. Early people, like other animals, did not greatly disturb the natural systems, for their numbers were strictly controlled by available food. Later hunter-gatherers, however, were characterized by the following behavioral conditions: (1) they had become the dominant animals in every ecosystem they occupied, (2) they eliminated competition from other predators by hunting them as well, and (3) they had some influence over which animal and plants lived in their territory (Fagan 1977). As human activities became more specialized, new socio-economic conditions developed which led humans to compete for the same limited resources. For the first time, humans laid down the conditions which ever since have resulted in significant environmental impacts.

EARLY COLLISIONS OF CULTURAL VISIONS

Eventually, people began to shift from a hunting and gathering way of life to a more specialized agriculture-based economy. The cultures resulting from this process displayed great diversity geographically. These "village cultures", as they are often denoted by historians and geographers, not only developed particular sets of site-dependent relations with their environment, but also distinctive philosophical views for interacting with their physical environment (Poffenberger 1990). In most of earth's bioregions, a significant number of village cultures (tribes or clans) dominated the landscape, each with a unique sociological and ecological history. Generally, these village cultures had considerable knowledge of natural and technological processes but little systematic study of nature, few traces of a scientific tradition, and no scientific institutions (Callicott 1989). In these cultures, the bond between man and nature was still very strong.

Several factors and conditions may have accelerated or precipitated the socioeconomic transition from village cultures to intensive-food producing societies. Though still controversial, recent evidence (Dorn 1991) suggests that this change was neither the direct result of an agricultural invention nor any fundamental revision of man's relationship with nature; it was sparked instead by a realignment of ecological variables, primarily increasing population density and diminishing availability of collectible plants and large-bodied animals. As these emerging societies developed more complex economies, their administration became more centralized, along with which came an aggressive process of assimilation of local cultures spelling the loss of their ecological knowledge. As a result, a collision of visions about approaches to interacting with natural ecosystems took place. It is speculated that this human tragedy influenced the

collapse of ancient kingdoms in Egypt, Mesopotamia, India, China, and the New World. Continuing until today, these cultural collisions have been a matter of continuous political struggle between people and governments, and ultimately between man and nature.

Since every society sees civilization in its own way, it is then difficult to determine the exact moment at which civilization first appears in world history. Most definitions of "civilization" reflect ethnocentrism or a value judgement. If civilization is defined by literacy and a preference for urban life, then its origins go back to the beginnings of towns and city-states in Egypt and Mesopotamia. The consequences of urban life most important to human history were in politics and social history. As urban societies appeared, the man-nature separation process accelerated, and for the first time man began to change the natural world significantly. Urbanization brought about a deep misunderstanding between "city cultures" and "nature cultures", a problem deeply rooted in the history of collisions of cultural visions with respect to natural ecosystem management. Similar cultural conflicts have taken place in many other regions of the world.

Critical to the development of the great ancient kingdoms was the organization and centralization of political decision-making power (Dorn 1991). In contrast to the social structure of village cultures, the governments of these kingdoms exerted strong influence and control on the relationships between man and nature. Science and technology, as developed by local cultures, were forced by centralized governments to change towards a utilitarian approach. Moreover, though with less emphasis in classical Greece, the governments of these kingdoms financed science and bureaucratized its pursuit. Generally, science and technology were patronized to sustain agricultural development, and as such were of considerable social importance and of central interest to the government authorities. It has been suggested that the intensification of irrigation agriculture, which encompassed the development of an extensive network of hydraulic infrastructure and intensive labor, could not have been possible without a centralized authority. Most of the ancient major states started from a irrigated agriculture, which cannot be a mere historical coincidence. On the social foundation of irrigated agriculture, unilateral approaches to land use management were imposed on the local cultures. Natural forest ecosystems, under the dominance of these centralized monocultural visions, began to be destroyed at alarming rates.

Traditional cultures were not necessarily more noble or wiser than the great centralized cultures in the ways they interacted with the natural environment. Each culture's sociohistory is driven by material and ethical considerations (Rappaport 1974). Some cultures have chosen to be more material while others have been more contemplative and mystical about the marvels of nature. These extremes of cultural behavior evolved into a broad array of societies with a different vision of the natural world. Few of these societies chose to be scientifically and technologically advanced, while many others decided to live according to their traditional knowledge and culture. Whereas village cultures were forced to adapt to their surroundings in order to survive, the great civilizations had the power and technology to impose a singular vision over vast areas with no adaptation for local cultural and ecological factors.

Sociohistorical analyses have often been approached from a disjointed or unrelated perspective. Most analyses, far from considering the ecology-economy interplay of these ancient societies, which could provide a holistic explanation of their socio-ecology history, have tended to emphasize one factor at a time. Historians, particularly those dominated by a materialistic philosophical view, have concentrated on "modes of production". This taxonomy of social systems, in contrast to holistic analyses, has a utilitarian tendency which emphasizes an historical determinism of social development and clearly masks the fact that man and society are an integral part of natural ecosystems.

Generally, the socio-history of ancient cultures reveals that the centralization of land use policies accelerated the process of man's separation from nature and limited Mans' freedom for developing a genuine philosophy of nature. Cultural conflicts, and competition for nature control, precipitated the decline of many great cultures. In each case, the decline was correlated with the decline of agriculture. As most records suggest "because the fertility of the land was decreased, the kings who followed were no longer of such consequence as those who went before" (Dorn 1992). Whatever the exact circumstances, the rise and decline of ancient cultures shows a strong correlation with the cultural separation of man from nature, a process induced by the centralization of social and political institutions.

In many ways, the sociopolitical and cultural history of ancient hydraulic civilizations influenced profoundly the sociospheres and biospheres of today's world. The socio-history of ancient cultures reveals a distinctive process of man-nature separation induced by centralized government policies. In most cases, the process is framed by sociopolitical conditions which are remarkably similar not only to other ancient cultures, but also to modern societies. Man-nature separation has been accelerated by the utilitarian emphasis of science and its political centralization.

MULTICULTURAL PHILOSOPHICAL VIEWS OF NATURE

A philosophy of the relationship between Man and nature was developed by those societies whose very existence depended upon knowing their natural physical environment and how to interact with it. In most cultures, both in the Old and New World, their views of nature are embedded in each culture's myths and traditions and embodied in each culture's supreme spirits and deities.

Historically, these cultures lived in different environments and adapted to their respective environments in diverse ways. In each of these cultures, aside from climatic or geographic differences, the relationship between man and nature had a multidimensional complexity. Each of these cultures, as a result of adapting to its environment, was bound to develop its own particular view of nature. A common characteristic shared by these cultures in their philosophy of nature is that not only plants and animals are alive, but also the rest of "things" of the physical world. According to this view, every physical feature of nature is endowed with spirit and sentience every bit as real and the same as in humans. Central in these cultural views was that man and nature were bound in unity. There was no separation between the human (willed, thinking, superior) and the non-human (conditioned, insensate, inferior). This has been a common thread in most of the early cultures across continents.

In ancient Greece, the local cultures developed a rich and complex philosophy of nature. With the emergence of urban centers, during the Mycenaean civilization (1600 to 1000 B.C.), the local culture's knowgledge of nature was forced to become more utilitarian in order to feed the needs of growing urban populations. Urbanization produced a sophisticated Greek society and science flourished (600 to 300 B.C.), but it failed to integrate the knowledge of local cultures to properly manage the land resources. Science during those times was decentralized and substantially useless. By the time of Pericles (500 B.C.), the agricultural base of Greece had been seriously damaged mainly by the effects of deforestation. Xenophon in 400 B.C. wrote, perhaps as a result of the ecological and economic poverty in which Greece was immersed, "Earth is a goddess and teaches justice to those who can learn...the better she is served...the better she gives in return". During that time, Greece socio-history began to shift political direction.

Eventually, population pressures against the food supply drove Greeks off their peninsula and force them to colonization, commerce, and conquest (Dorn 1991). The hybridization of Greece's science with that of the other mediterranean cultures resulted in the development of more advanced technological societies. Eventually, these societies evolved into what it is called "science cultures", societies in which the predominant general trend revolves in the vision that "domination of nature involves domination of man"

Western Europe provided continuity to Greece's mechanistic philosophy of nature and its utilitarianism by mediterranean and eastern hydraulic civilizations. Greece's ideas revolutionized science in Europe and its applications were institutionalized. Later this philosophy of nature was taken to North America and eventually all over the world.

Europeans' view of nature, as it took root in American soil in the nineteenth century, has been described as "analogous to a machine,..., nature is a machine" (Callicott 1989). In contrast, the American indian viewed the world as a mother and father, a concept shared by most indian cultures all over the world. Ever since a mechanistic view of nature was implanted throughout the world, a continuous process of collision of cultural visions has been shaking our social and political institutions. These cultural variables, given the intensity and direction of their manifestation, are significantly influencing the political environment of the decision making process in forest ecosystem management.

ECOSYSTEMS AND PEOPLE

At any level of scale, the ecosystem concept provides a flexible framework for integrating multicultural perspectives into the management of forest and rangeland systems. For any given space-time dimension of the ecosystem, it is not just biological populations that interact with the biosphere, but living human beings capable of making economic and political choices (the "sociosphere"). While natural systems have been evolving for millions of years, the sociosphere came to be a part of the natural scenario only very recently. In addition, natural ecosystems are continuous units linked at different levels of geographic scale. Sociosphere systems, on the other hand, are encompassed by a variety of geopolitical units (nations, peoples, cultures, institutions), each with different perceptions and values. As any other biological population, the sociosphere elements (humans) are ecosystem components, but their activities cause significant ecological disturbance which, in many cases, result in habitat destruction and species extinction. The ecosystem concept implies that human interactions on the biosphere must be managed first before attempting to manage ecosystems. In making the ecosystem concept operational, the differences in perceptions and values of people must be seriously taken into account, otherwise the practice of ecosystem management is bound to be just "business as usual".

The ecosystem concept is emerging as a framework for humans to interact with the biosphere. In many sociospheres the ecosystem concept is gaining political support for use in management applications. Ecosystem management, therefore, appears to be the new paradigm for natural resource management. Within the USDA Forest Service, for instance, the Chief has defined ecosystem management to mean ..."using an ecological approach to achieve the multiple-use management of national forests and grasslands by blending the needs of people and environmental values in such a way the national forests and grasslands represent diverse, healthy, productive, and sustainable ecosystems." The recognition that people are a critical part of the equation to achieve ecosystem sustainability is a necessary condition for making ecosystem management operational. In contrast to traditional forest management views, the ecosystem

management approach provides limitless possibilities for integrating the complex nonlinearities of people into the framework of natural ecosystems.

An example of this evolution in thought has begun to take place in Mexico. The Mexican government recently passed a sweeping set of natural resource management and environmental protection laws that call, among other things, for integrated, multiple use management of the nation's forests under sustainable ecological principles (SARH 1992). Current Mexican forest policy is promoting the integration of local cultural perspectives into forest ecosystem management. Several examples now exist in which forest ecosystems are being managed by integrating local cultural views. In this process, landowners and forest ejidos are required by law to include multiple use and multiple resource criteria in their integrated forest management plans. Ecosystem management, in most cases, is being implemented as a learn-as-you-go incremental process of adaptive management. Community participation, and the formation of partnerships as a means to minimize conflicting cultural views, have been fundamental in making ecosystem management operational (Kidd and Pimentel 1992, Gerlarch et. al., 1993). The use of an ecosystem approach to forest resource management provides decision makers a framework for understanding that decisions made at the local level are bound to have regional, and even global, consequences.

Ecosystem management is meaningless if the various scales of its geographic linkages are ignored in making it operational. The ecosystems of North America, such as the Colorado-Rio Grande Rivers, the Chihuahuan and Sonoran Desserts, or the mountain forests in Mexico which are critical for migratory bird populations, provide objective examples of the continental and global complexities of ecosystem management. In addition, these ecosystems are the ground on which complex sociosphere systems interact, according to their respective perceptions and values. Across the landscape, whether at a regional or global scale, there are numerous local cultures whose particular ecological histories and values could be shared with the rest of the global community and integrated into the framework of forest ecosystem managent (Kidd and Pimentel 1992). Multicultural participation at all levels ensures drawing on a wider array of knowledge than previously, and a better use of the adaptive experience of local cultures for making ecosystem management operational.

The global dimension of ecosystem management calls for international cooperation and participation. Today, after 200 years of industrial revolution and scientific accomplishments, society is beginning to realize that the world is ominously different. The global environmental problems confronting all societies cannot be blamed on science and technology, but on the dominant role of social and political institutions for implementing monocultural visions of the human-nature interplay. Rather than go back to the time where humans were hunters and gatherers, the sociohistory of humanity has to be redirected towards a higher level of integration with natural ecosystems. Initially, this new trend was explored by Charding (1959) under the name "noosphere". Recently, Allen and Hoekstra (1992) discussed the significance of this concept to the management of ecological systems.

The global complexities of human actions on natural ecosystems have been recognized at the highest level of government and by international government organizations. In the USSR, former President Mikhail Gorbachev in discussing ecological security stated that: "for all the contradictions of the present-day world, for all the diversity of social and political systems in it, and for all the different choices made by the nations in different times, this world is nevertheless one whole. We are all passengers aboard one ship, the earth, and we must not allow it to be wreckeed. There will be not a second Noah's Ark." Likewise, former president George Bush declared: "No line drawn on a map can stop the advance of pollution. Threats to our environment have become international problems. We must develop an international approach to urgent environmental issues." It is implicit in the above statements that ecosystem management has multicultural and global linkages. It is also clear that solutions to ecological problems cannot be found only in the corridors of Washington or of any other institution, but in the planning process of truly integrating multicultural values into forest ecosystem management.

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MANEJO DE POBLACIONES DE *Yucca schidigera* COMO UN RECURSO SOSTENIBLE

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Resumen.—*Yucca schidigera* es una planta muy importante de la región árida del suroeste de Estados Unidos y noroeste de México. Esta planta es aprovechada por su valor comercial en México, cosechandose cerca de 3 mil toneladas anuales y en su mercado intervienen 1,500 comerciantes locales. La demanda de este producto es muy superior a la oferta ya que se estima que puede ser aporximadamente diez veces mas. Varios modelos se han desarrollado en base a investigaciones y estudios autoecológicos para desarrollar estrategias de manejo en el aporvechamiento. Se determino, que ademas del aprovechamiento adecuado, las poblaciones naturales pueden ser afectadas si no se aumenta la producción de fuestes y que es posible domesticar la especie y realizar plantaciones comerciales, por lo que es necesario la elagoración de modelos en base a factores económicos y ecológicos para determinar los ciclos de corta óptimos en esta especie.

INTRODUCCION

Varias plantas del desierto tienen gran valor comercial, la *Yucca schidigera* es un buen ejemplo. Tradicionalmente tiene muchos usos y se comercializa en diversas formas. Los usos potenciales de esta especie no se han determinado totalmente, mas sin embargo como otras plantas económicamente importantes tiene el riesgo de que las poblaciones naturales sean sobreaprovechadas.

Los objetivos del presente trabajo fueron los de determinar: (1) la autecologia (en parte) y conocer los cambios en la estructura en una población de palmilla sujeta a cortas; (2) determinar el efecto de las cortas sobre el potencial reproductivo sexual de la poblacion; (3) determinar el crecimiento anual en altura y (4) conocer las relaciones dimensionales de la especie.

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USOS

El género Yucca ha estado muy ligado a las culturas indígenas de Norteamérica y México, se tienen evidencias de que se utilizó como fuente de fibras, para la elaboración de ropa y lazos, medicina, detergentes, materiales para construcción de choza rústicas, artículos decorativos, arpilleras y otros objetos útiles al hombre e inclusive como alimento utilizando el tallo, raíz, hojas o inflorescencia de la planta según el caso. Sus hojas y tallos han servido como forraje, ensilados o picados en verde, en áreas desérticas en épocas de prolongadas sequía, (Webber 1953). La inflorescencia de *Yucca schidigera*, es utilizada entre los nativos Pai-Pai y Kiliwas, como alimento y como forraje para el ganado (Amaro 1980). El jugo de *Yucca schidigera* es empleado como agente limpiador de ropa. Los troncos de Yucca se usan en varias regiones del norte del país para construír chozas, cercas, corrales y como fuente de energía en lugares donde escasea la leña.

Los usos actuales industriales tambien son muchos, pudiendose obtener del jugo saponinas, esteroides, proteínas, hormonas y base para fertilizante (Webber 1953, Amaro 1980).

Los usos potenciales incluyen productos como lubricantes, aditivos para cosméticos, y otros farmacéuticos.

REVISION DE LITERATURA

En el Estado de Baja California Norte, existen tres especies del genero Yucca: *Y. whipplei* (Torr.), *Y. valida* (Brandegee), y *Y. schidigera* (Roezl. ex Ortgies) (Shreve and Wiggins 1964, Hasting 1972, Piña 1980). La especie que actualmente se encuentra en explotación es *Yucca schidigera* comunmente conocida como palmilla. De acuerdo a Hasting (1972) la distribución de esta especie comprende desde el Sur de los Estados de Nevada, Arizona y California en los Estados Unidos hasta el Paralelo 30° de latitud norte en la Península de Baja California, encontrandose las poblaciones más densas en el Valle de la Trinidad, B.C. México.

La información existente sobre reproduccion, edad y desarrollo de esta especie es escasa y en ocaciones empírica; Sandoval (1980) reporta que la palmilla posee dos formas de reproducción: La sexual y la vegetativa (por rizomas), esta última según el autor es la más común. Amaro (1908) basándose en información obtenida en áreas de aprovechamiento y apoyandose en las experiencias de los habitantes del lugar concluye que: "el desarrollo inicial en altura hasta la edad de 4 o 5 años es lento después, se oberva un rápido crecimiento hasta alcanzar 1.3 m a 1.4 m y a partir de 1.50 m de altura (la cual es alcanzada a los 15 años) el incremento en diámetro y altura se vuelve muy lento disminuyendo por lo tanto su rendimiento". Webber (1953) reporta que el incremento anual promedio registrado en plantas de palmilla de 15 años fué de 2.4 cm sin riego y 7.4 cm con riegos de auxilio.

Respecto a la edad de la palmilla McKelevey (1938) reporta que la edad de algunos individuos de *Y. brevifolia* (especie que alcanza una altura maxima de 2.4 m) se estima entre 600 y 800 años y al referirse a *Y. schidigera* opina que esta tiene un crecimiento tan lento como la primera.

DESCRIPCION DEL AREA DE ESTUDIO

El área de estudio se localiza en el Valle de la Trinidad, Baja California Norte, dentro del Ejido Francisco R. Serrano, que se encuentra a 150 kms. al este de la ciudad de Ensenada (figura 1). En esta localidad se lleva a cabo el 90% de los aprovechamientos que se realizan en palmilla. El clima predominantemente es cálido seco, extremoso, y con lluvias invernales. La fisiografía consiste en una combinación de valles intermontanos abiertos asociados con lomeríos y planicies. Los sitios mas preferidos por la Yucca, son terrenos planos con suelos profundos, aunque también se le puede encontrar en laderas.

Figura 1. — Area de estudio en el Estado de Baja California Norte, México.

La vegetación es típica del Matorral Desértico Crasorosulifolio (Brown y Lowe 1980) con las siguientes especies associadas: mezquite (*Prosopis juliflora*), jojoba (*Simmondsia chinensis*), ocotillo (*Fouqueria splendens*), *Agave* spp., y choya (*Opuntia cholla*).

MATERIALES Y METODOS

A fin de detectar la existencia de cambios originados por los aprovechamientos en la estructura vertical (altura de los individuos) u horizontal (número de individuos/colonia), se seleccionarón 9 áreas aprovechadas en forma sucesiva (una por año) partiendo de la aprovechada en 1979. Se utilizó un muestreo al azar empleando sitios circulares de 1000 m2. Las variables medidas fueron: 1) Número total de individuos por colonia, 2) Número de tocones (individuos aprovechados) en la colonia, 3) altura del tallo, 4) Diámetro del tallo, 5) altura de la roseta y 7) Diámetro de la roseta.

RESULTADOS

Relaciones Dimensionales de la Planta

Una de las primeras acciones realizadas en el proyecto fué el de obtener las relaciones dimensionales de los principales atributos de la planta con el propósito de derivar modelos de predicción. En la figura 2 se presentan las diferentes variables que fueron consideradas para este fin.

Para cada par de colonias, se corrió una regresión por el método de "stepwise Analysis" a fin de obtener el mejor ajuste en el modelo.

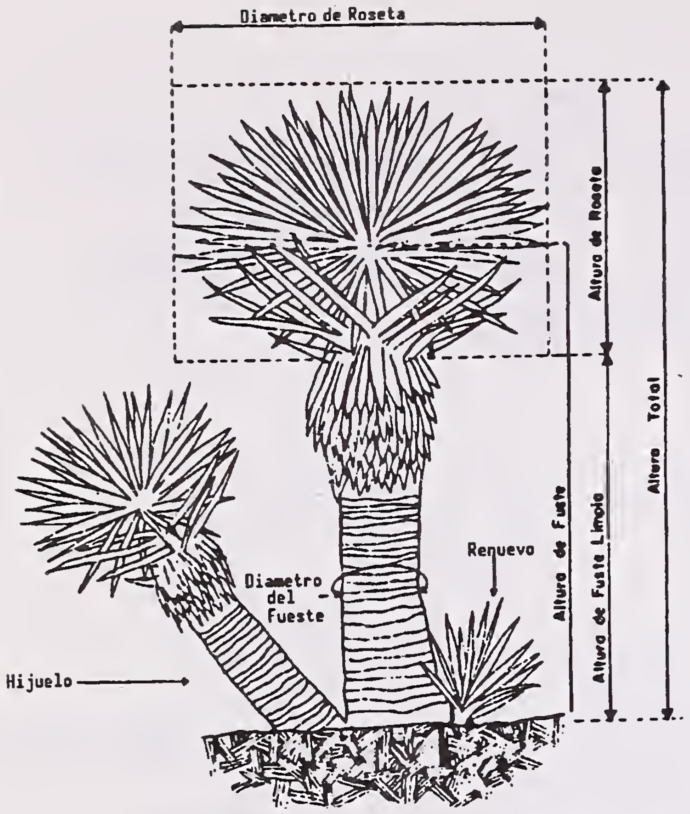

Figura 2. — Componentes y atributos de una colonia de *Yucca schidigera*.

Altura Total vs. Altura del Fuste

En la figura 3 se presenta el modelo obtenido para la relación descrita. Como se puede observar, la relación altura total vs. altura de fuste sigue un comportamiento lineal. El coeficiente de determinación (R^2) del análisis es de 0.95, indicando que el efecto lineal presenta el 95% de la variación debido a la altura del fuste, por lo que en este modelo la altura total resulta un buen predictor de la altura del fuste. Es necesario mencionar, que en todas las relaciones dimensionales de la planta considerada en el estudio, se tomó a la altura total como la variable independiente debido a que es el atributo de la planta mas facil de medir en el campo.

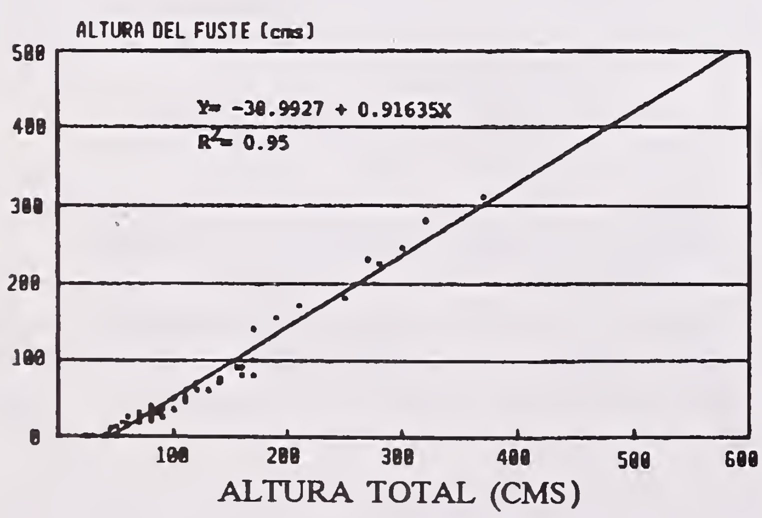

Figura 3. — Modelo de regresión entre la altura total y altura del fuste.

Altura Total vs. Altura de Fuste Limpio

La altura de fuste limpio se definió para este estudio como la diferencia entre la altura total menos la altura de la roseta. En la figura 4 se presenta el modelo obtenido entre las variables. En este modelo se obtuvo una R^2=0.94 indicando que el efecto lineal del modelo representa el 94% de la variación debido a la altura de fuste limpio. Como en el caso anterior, la altura total resultó un buen predictor de la altura del fuste limpio.

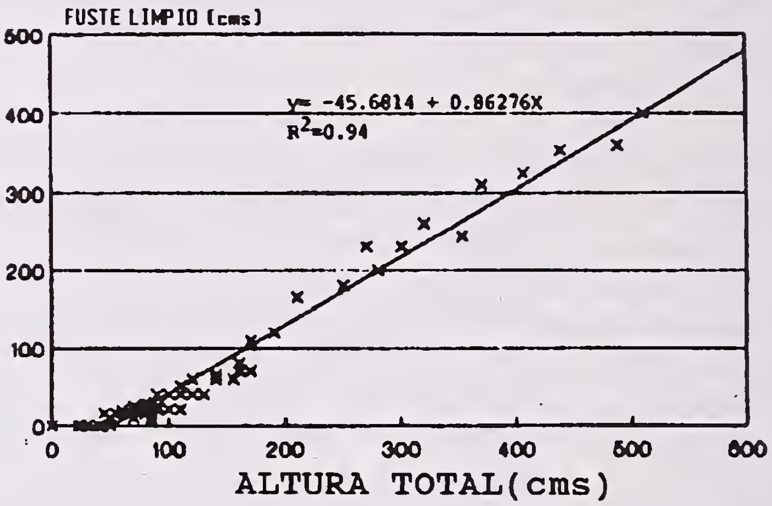

Figura 4. — Modelo de regresión entre la altura total y altura de fuste limpio.

Este modelo es de especial importancia debido a que obtienen las dimensiones de la parte de la planta de mayor interés desde el punto de vista de los aprovechamientos, ya que es el fuste limpio el que se industrializa, mientras que la roseta se corta y se desecha.

Altura Total vs. Diámetro del Fuste

Una de las variables que representan un mayor grado de dificultad para me dir es el diámetro del fuste dado las características de la especie, basado en lo anterior se trató de obtener un modelo que predijera el diámetro del fuste. Como se puede observar en el modelo de la figura 5 el efecto cuadrático de altura total representó el 96% de la variación debido a los valores del diámetro del fuste, nuevamente la altura total puede predecir con aceptable presición el diámetro de fuste a través del modelo matemático respectivo.

En forma adicional se obtuvo el modelo inverso que predice la altura tomando como base el diámetro del tocon ya que se consideró indispensable para determinar "piso", es decir el potencial de crecimiento de la planta en un sitio determinado en áreas que fueron intervenidas y de las cuales se carece de datos. El modelo obtenido fué $Y=22.0689+3.1933X+0.29431X^2$ con un R^2=0.97.

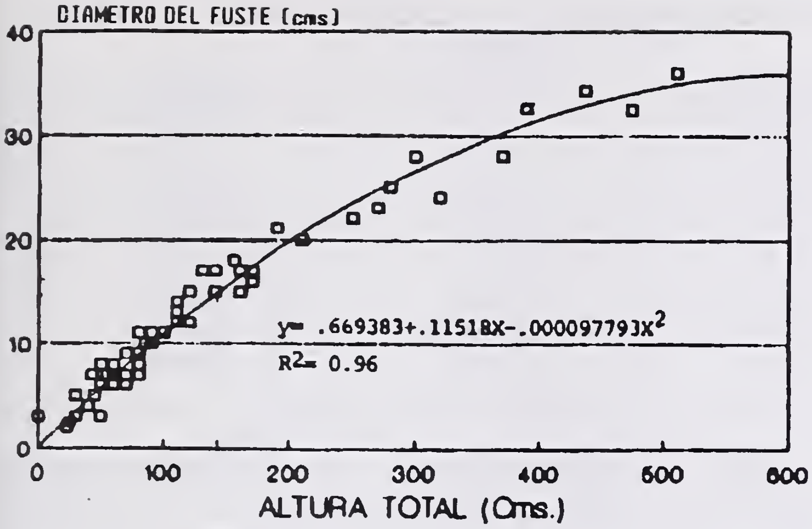

Figura 5. — Modelo de regresión entre la altura total y el diametro del fuste.

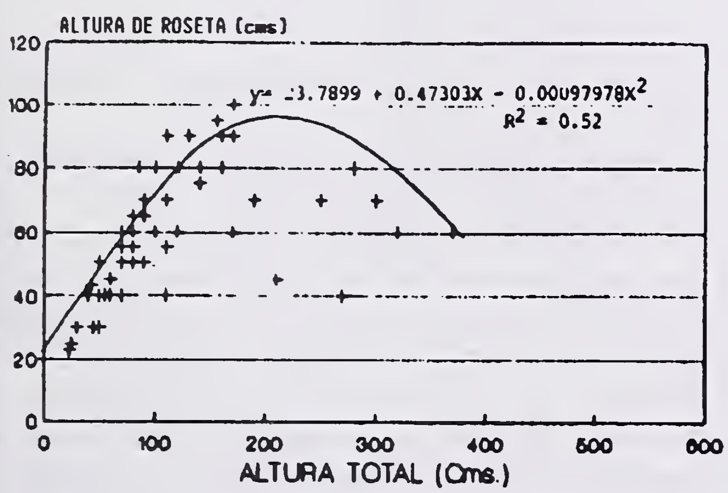

Figura 6. — Modelo de regresión entre la altura total y la altura de la roseta.

Altura Total vs. Altura de la Roseta

En el análisis de regresión para las variables Altura Total y Altura de Roseta se encontró que el modelo que mayor se ajusta a los valores fué el que se presenta en la figura 6. En ésta, se puede apreciar que el coeficiente de determinación solo expresó el 52% de la variación. El "ruido" que se observa en el modelo se debe probablemente al hecho de que existen plantas que por diversas circunstancias entre ellas la compentencia interespecífica son suprimidas en su crecimiento, convirtiendose en "enanos seniles" por lo que en estos, los valores de altura total no están asociados con los de altura de roseta. Esta situación se presenta en forma similar en el análisis de regresión efectuado entre la altura total y diámetro de roseta (figura 7). De esta forma, más que los modelos en sí (altura de Roseta y diámetro de la Roseta) lo importante es la tendencia que se observa en los valores de las variables ya que ésta, tiene una implicación en los criterios que se utilizán a la fecha para determinar el "marqueo visual" es decir la selección de los individuos que se consideraron como aprovechables.

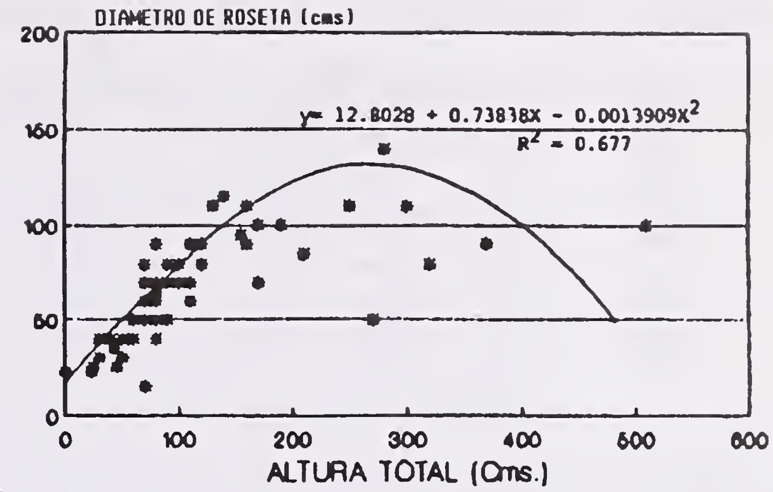

Figura 7. — Modelo de regresión entre la altura total y el diametro de roseta.

Actualmente y en poblaciones no intervenidas el criterio de selección de un individuo para ser cortado es la proporción que guarda la longitud del fuste y el tamaño de la roseta, considerando que una planta en la cual la longitud de la roseta representa 1/5 del tamaño total, es una planta con signos de decrepitud y apta para ser aprovechada. Este metodo de selección "Empírico" en términos generales coincide con la tendencia presentada en los modelos de las figuras *6* y *7*. Sin embargo, este criterio solo es posible aplicarlo en aquellas áreas no aprovechadas. Para áreas que ya fueron intervenidas al ser extraídos todos los individuos sobremaduros y/o decrépitos, el criterio de selección debiera tener como base la dinámica estructural de las problaciones a fin de evitar una sobreexplotación del recurso.

Efectos de las Cortas de la Estructura Horizontal

Los resultados obenidos a través del análisis de varianza entre treinta colonias aprovechadas y treinta no aprovechadas (testigos) en cada una de las anualidades, mostró diferencia significativa (P). Basado en los resultados del análisis de varianza se realizó para cada anualidad una prueba de diferencia mínimas significativa (DMS). Los resultados de este análisis se presentan en el cuadro 1.

Como se puede apreciar en todas las anualidades se registró un número significativamente mayor de individuos en las colonias aprovechadas que en las no aprovechadas. Basados en éstos resultados se concluyó que: 1) En las colonias no aprovechadas los individuos adultos mantienen una dominancia sobre los otros miembros de la colonia; 2) El corte de individuos adultos en los aprovechamientos, dispara la estrategia reproductiva asexual de la planta promoviendo la generación de nuevos individuos en la colonia.

En la figura 8 se presentan las medidas de individuos por colonia para cada una de las anualidades, asimismo, en la figura 9 se muestra la tendencia de las diferencias netas

CUADRO 1. — Prueba (DMS) entre el número de individuos en colonias aprovechadas y no aprovechadas de *Yucca Schidigera*.

AÑO	APROVECHADA	NO APROVECHADA	DIFERENCIA	VALOR CRITICO T	PROB
1979	11.89	7.37	4.52	2.6979	0.0035
1980	10.52	7.11	3.41	2.4582	0.0282
1983	12.98	8.59	4.39	3.2775	0.0354
1984	10.67	7.04	3.63	2.6165	0.0035
1985	9.43	5.03	4.04	2.2547	0.0002
1986	8.07	4.49	3.58	1.9671	0.0006
1987	6.83	5.49	1.34	1.1484	0.0288
1988	7.38	4.58	2.80	2.0945	0.0163
1989	5.81	4.02	1.79	1.3505	0.0335

obtenidas, sinedo ésto la cantidad real de los individuos que se integraron a las colonias aprovechadas en relación a los años transcurridos después de su intervención.

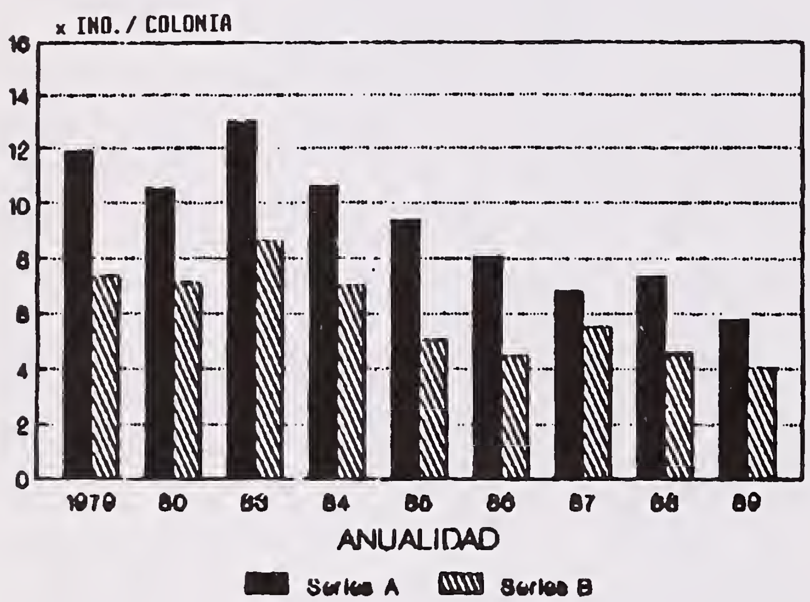

Figura 8. — Medias de individuos en colonias aprovechadas (A) y no aprovechadas (B).

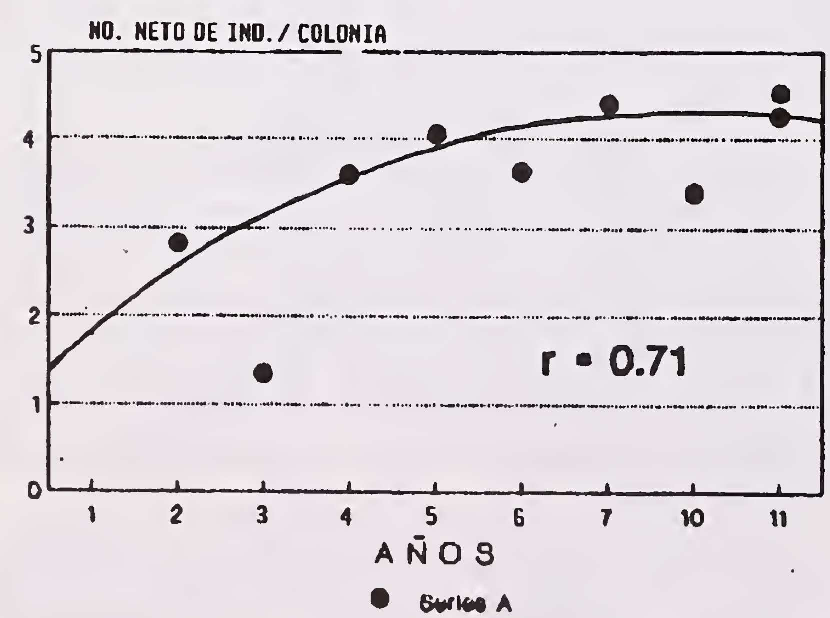

Figura 9. — Tendencia en la incorporación de nuevos individuos en colonias aprovechadas en función al tiempo.

Estos valores, mostraron una correlación positiva (R=0.71) con una tendencia asintótica hacia los valores máximos de las medias, lo que se interpreta como el limite de individuos que una colonia permite en cuanto a la incorporación de nuevos individuos, cabo ésta recuperación.

Efecto de las Cortas en la Estructura Vertical

Los valores obtenidos de las medias ponderadas de colonias aprovechadas respecto a sus testigos en cada anualidad, tuvieron un comportamiento inverso a los observados entre las densidades de individuos por colonia (Figura 10). Esto se debe a la eliminación de los individuos más grandes de la colonia en los aprovechamientos y a la incorporación de los nuevos individuos en los estratos de altura inferiores. Sin embargo, también se oberva que las diferencias entre las plantas aprovechadas y su testigo se hacen más marcadas en las anualidades más recientes (hasta 1986) para después encontrar valores muy similares en las anualidades anteriores. Adicionalmente, los rangos máximos registrados tanto para colonias aprovechadas como no aprovechadas, mostraron un patrón semejante a los resultados anteriores. Los valores de los rangos fueron similares entre las anualidades de 1979 a 1985; a partir de la anualidad de 1986, este rango se extiende más hacia las clases de altura mayores en las colonias no aprovechadas (Figura 11).

Estos resultados muestran que la intensidad de corte efectuada en las colonias aprovechadas no ha tenido un efecto servero en la estructura vertical de la población y es probable que se de una recuperación muy dinámica en la estructura vertical originada por la liberación de los individuos de las categorías anteriores.

Efecto de las Cortas Sobre el Potencial Reproductivo de la Planta.

Como se mencionó anteriormente, la respuesta de la colonia de plantas al corte de individuos adultos dominantes, acciona el mecanismo de reproducción asexual de la planta. En términos de supervivencia éste es un mecanismo

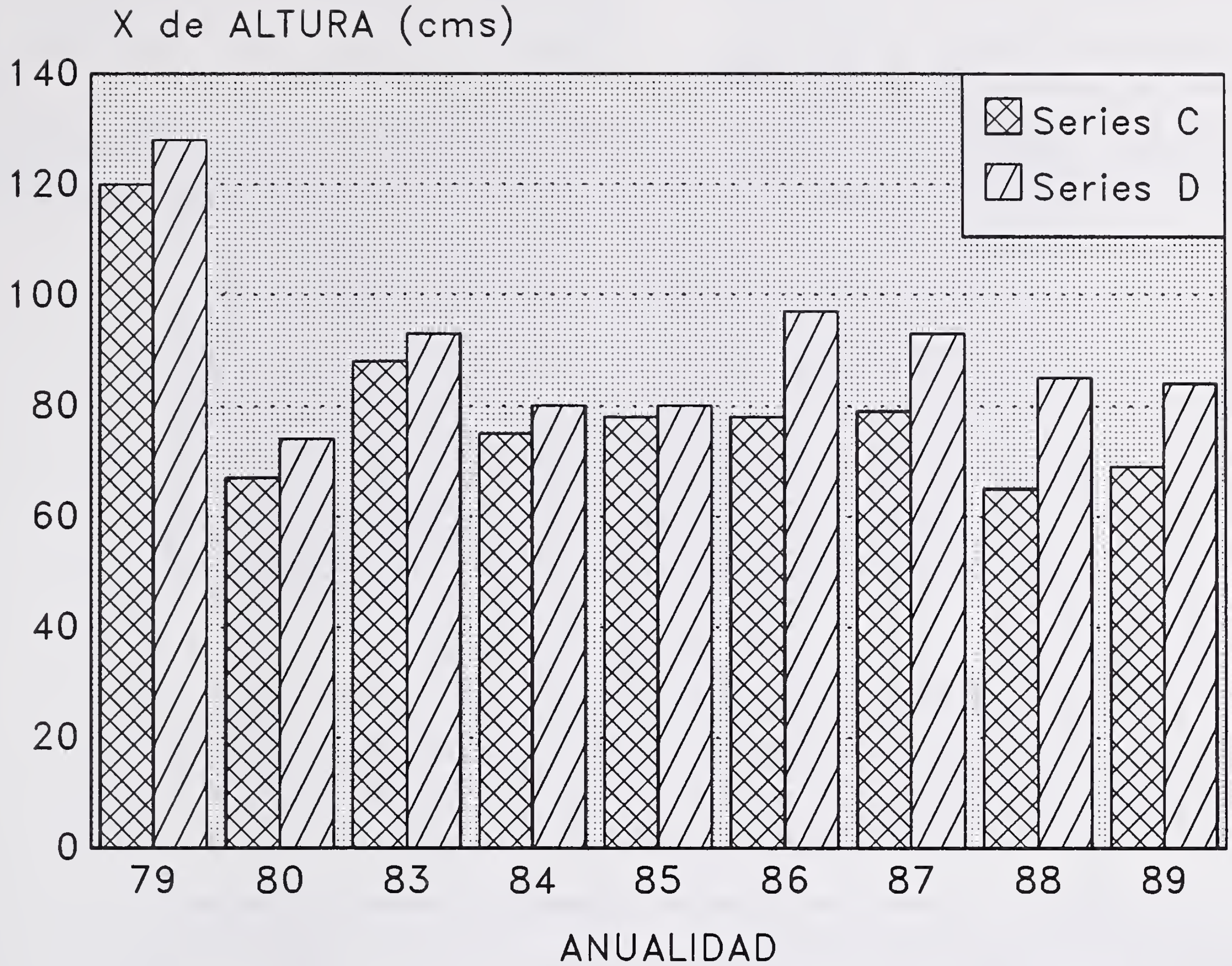

Figura 10. — Diferencias de altura entre colonias aprovechadas (C) y no aprovechadas (D).

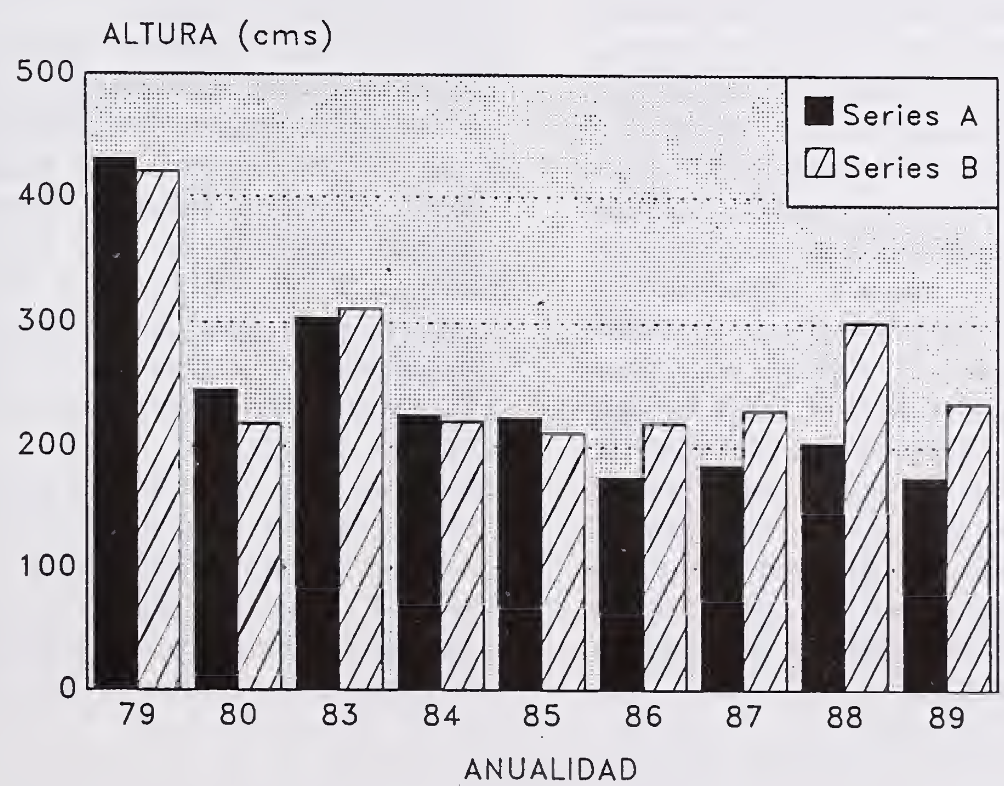

Figura 11. — Rangos de altura de individuos en colonias aprovechadas (A) y no aprovechadas (B).

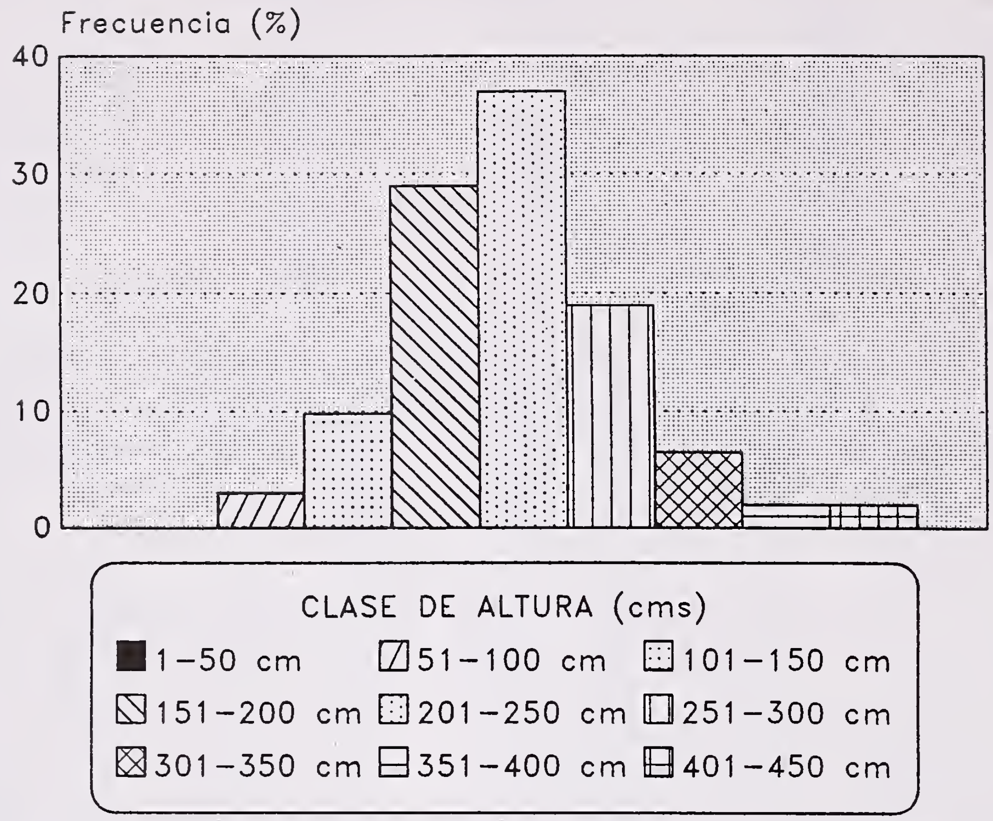

Figura 12. — Presencia de frutificación en relación a las alturas de las plantas.

frecuente entre especies que se desarrollan en habitat poco productivos debido a que existeuna probablidad mayor que el nuevo individuo se logre al amparo de las plantas progenitoras. En la literatura sobre palmilla, se mensiona que en raras ocasiones se han registrado individuos generados por reproducción sexual; sin embargo, para fines de un manejo tecnificado de este recurso, éste es un punto que no se debe soslayer, puesto que la diversidad genética es un aspecto importante para la conservación del recurso. Basados en lo anterior y como una información adicional al proyecto, se consideró de interés conocer en cual clase de altura la presencia de la fase productiva es más frecuente (Figura 12).

Como se puede observar la fase productiva (fructificación) se presentó con baja frecuencia en la clase de altura de 100 cms. incrementándose en forma notable en las clases de alturas inmediatas, alcanzando su valor máximo entre los 200 y 300 cms., para después descender en forma drástica en las clases superiores a los 300 cms. estos resultados son de gran importancia desde el punto de vista técnico, sin embargo, dada la longevidad de la planta se requiere mayor información para determinar una intensidad de corta adecuada a fin de balancear los factores económicos y ecológicos en áreas en donde se pretenda una nueva intervención. Gran parte de esta información, será generada por los sitios permanentes de investigación silvicola que fueron considerados en este proyecto.

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The Effect of Irrigation Water Quality and Harvest Intensities on Survival and Growth of Fourwing Saltbush

J. Rafael Cavazos Doria and Earl F. Aldon[1]

Abstract — Fourwing saltbush (*Atriplex canescens* [Pursh.] Nutt.) is an important species in arid and semiarid plant communities throughout southwestern United States and northern Mexico. It provides high quality forage for both domestic livestock and wildlife. It is highly palatable, drought resistant, and provides good soil erosion protection. Removal of all top growth caused 60% mortality regardless of watering system. Harvesting 50% of above-ground growth allowed 87% survival. There was no difference between the supplemental irrigation treatments (saline and fresh water), but using natural rainfall only resulted in smaller plants.

INTRODUCTION

Fourwing saltbush (*Atriplex canescens* [Pursh.] Nutt.) is a valuable and common shrub on western ranges in the United States and Mexico. It is widely distributed from North Dakota to Oregon and as far south in Mexico as the States of Zacatecas and Baja California (Vines 1960). It occurs in arid and semiarid habitats, and is common in grassland and pinyon-juniper woodlands. Scattered individuals may be found in pine and fir forests. It is commonly associated with other *Atriplex* species (Wagner and Aldon 1978).

Propagation techniques using direct seeding methods or transplants have been described (Springfield and Bell 1967, Aldon 1984). Direct seeding is less successful than transplants due to low seed germination, inadequate seed bed preparation, and depredation by rodents and lagomorphs. Transplants can be grown under controlled conditions and planted when soil moisture is optimum and the probability of precipitation is greatest. Repellents can protect transplants from wildlife until they become established (Aldon 1984).

The objectives of this study were to determine survival and growth of fourwing saltbush subjected to 50% and 100% crown biomass removal where minimum amounts of supplemental saline and fresh water irrigation were applied on newly established plantations. Test results can be applied to degraded sites, or abandoned agricultural sites that are no longer able to grow crops due to saline soil conditions. This is a common problem in the southwest United States and the Baja region of Mexico. Saline well-water is often available for irrigation at these sites. Fourwing saltbush can tolerate this condition (Richardson and McKell 1980) and provide valuable forage and cover thus turning deteriorated sites into productive ones.

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METHODS

Study Location

The experiments were conducted at the Todos Santos Experiment Station near La Paz, Baja California Sur, Mexico. Todos Santos, located about 111 km south of La Paz at 15 m above sea level, receives an average of 182 mm of precipitation per year. Average temperature is 22.1 C with 1738 mm of evaporation per year. The topography is made up of small gentle hills and irregular ridges with storm arroyos crossing through the area which run after summer thunderstorms. Major associated native vegetation consists of *Pachycereus pringlei, Bursera microphylla, Fouqueria diguetii, Cytocarpa edulis, Lemaireocereus thurberi, Jatropha cinerea, Opuntia cholla, Yucca valida, Cercidium floridum, Simmondsia chinensis*, and *Turnera diffusa.*

The dominant soil series is *Sierosem*, a dark-brown, sandy-textured soil about 2 m deep with a pH of 7.3 to 8.9, low in organic matter, nitrogen, and phosphorous, but rich in potassium.

During the 3-year period (1990 - 1992), daily maximum and minimum temperatures and precipitation were measured at the weather station at the Todos Santos Experiment Station.

Seedling Development

Seeds were obtained from the USDA Soil Conservation Service Plant Materials Center in Los Lunas, New Mexico (accession #478837). Seeds were germinated at Todos Santos in a sandy nursery soil having a texture of 82% sand, 11% silt, and 7% clay that had been fumigated with methyl bromide. The seed bed was saturated with fresh water every third day.

All seedlings were transplanted 30 days after germination into 800 cm plastic, well-drained containers using the sandy nursery soil as a growing medium. Seedlings were grown at Todos Santos for 2 months in nursery beds under plastic shade screens (33% shade). The containers were irrigated 3 times a week with 100 ml of fresh water per plant.

Field Planting and Irrigation

A 3 X 2 factorial experiment in a randomized block design was used in the field on 1.0 ha area cleared of all vegetation and leveled. Irrigation furrows 15 cm deep and 24 m long were constructed at 2.0 m intervals over the area. The furrowed area was divided into 3 blocks to evaluate irrigation water quality. Each block was further subdivided into 2 harvesting intensity sub-plots (144 m^2 each) replicated 9 times. The irrigation water quality levels were:

a1) Saline well water (E.C. = 5160 mmoh cm^{-1} and NaCl = 2715 mg L^{-1}).

a2) Fresh water from the experiment station's water supply.

a3) No irrigation; natural precipitation only.

The harvesting intensities were:

b1) 50% of total plant height removed.

b2) 100% of total plant height removed (everything 10 cm above the soil surface). These heavy intensities were used to test what might occur if grazing is not controlled.

Fourwing saltbush transplants averaging 28 cm high were planted 1.5 m apart and 15 cm deep on the ridges above the furrows in October 1990. The planted experiment covered 7776 m^2 and contained 2592 plants.

Gravimetric soil moisture samples (0-30 cm) were taken weekly at random locations along the furrows in each sub-plot. When moisture levels fell below 5% of field capacity, the plots were irrigated. Irrigation water (saline and fresh) was applied in the furrows at a rate of 1 L sec^{-1} for about 4-5 minutes to bring soil moisture up to field capacity. Three irrigations were required: in March and July 1991, and July 1992. Electrical conductivity (E.C.) (mmhos cm^{-1} at 25 C) was measured from a vacuum extract solution of soil samples taken at 0-30 cm and 30-60 cm depths. These soil samples were taken at the time of planting and one day after each of the three irrigations.

Plant Harvesting

Plant crowns were harvested in October 1991 and again in July 1992. A more frequent plant harvesting schedule was planned, but slow growth and high mortality after cutting prevented it.

Plant height (from the soil surface to tallest part of the plant) and crown diameter (largest diameter plus smallest diameter/2) was measured monthly on eight randomly selected plants in each sub-plot and averaged. When harvested, the eight plants were divided into leaf/small-branch (cm) and large stem portions. Green and air-dry weights of these portions were determined.

Statistical Analysis

An analysis of variance and Tukey's multiple comparisons were made on plant height, plant crown diameter, and green weight of plant crowns after harvesting. There were no significant interactions between type of irrigation water (a1, a2, a3) and harvest intensity (b1, b2) in any of the analyses.

RESULTS

Plant Height

Plant height increased slowly growth during the first 6 months after planting (fig. 1). Transplants averaged 28 cm at planting time and grew about 20 cm during the first winter and spring months. Growth accelerated from June to September 1991. By the first harvest (October 1991), the plants irrigated with fresh water averaged 78.52 cm in height,

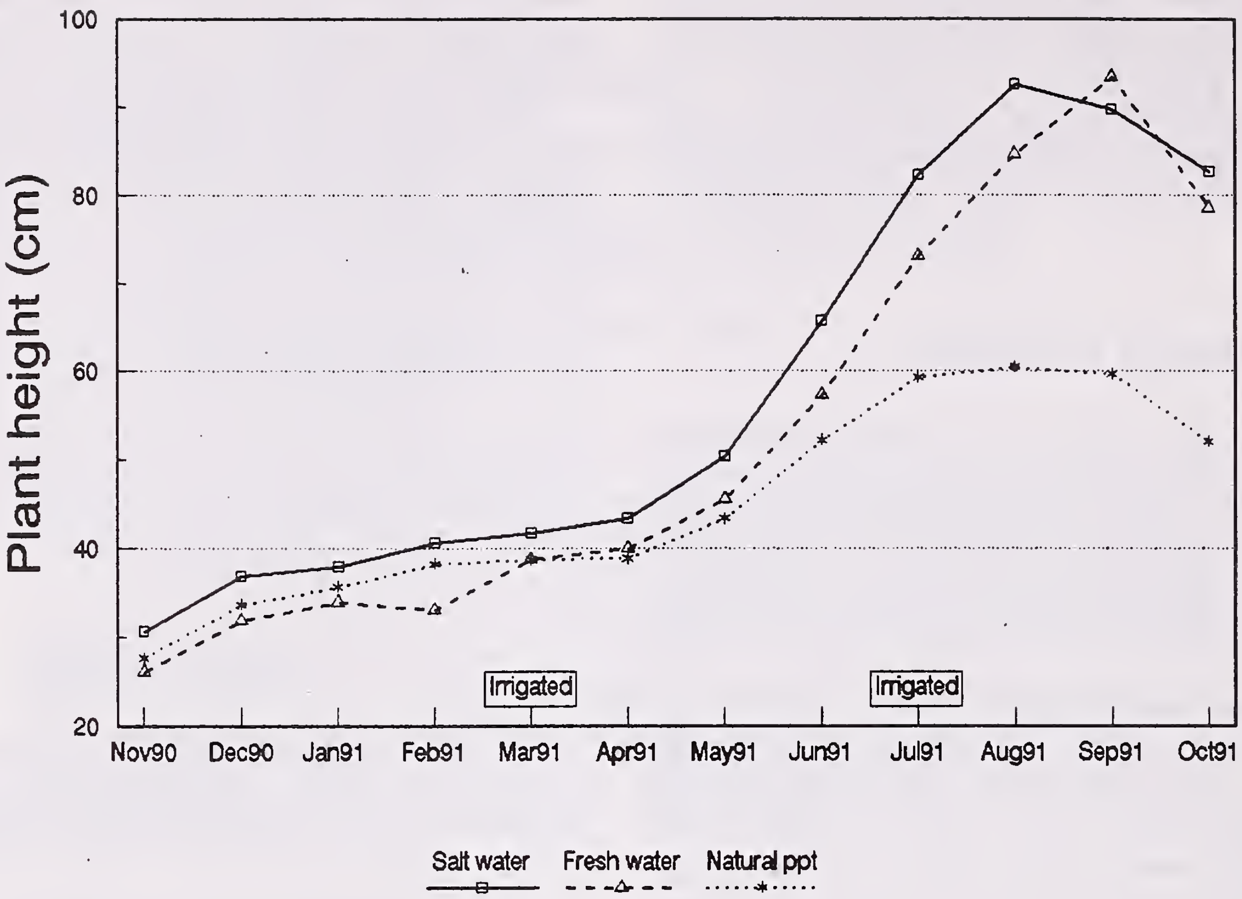

Figure 1. — Plant height (cm) of fourwing saltbush grown under three water regimes from planting to the first cut.

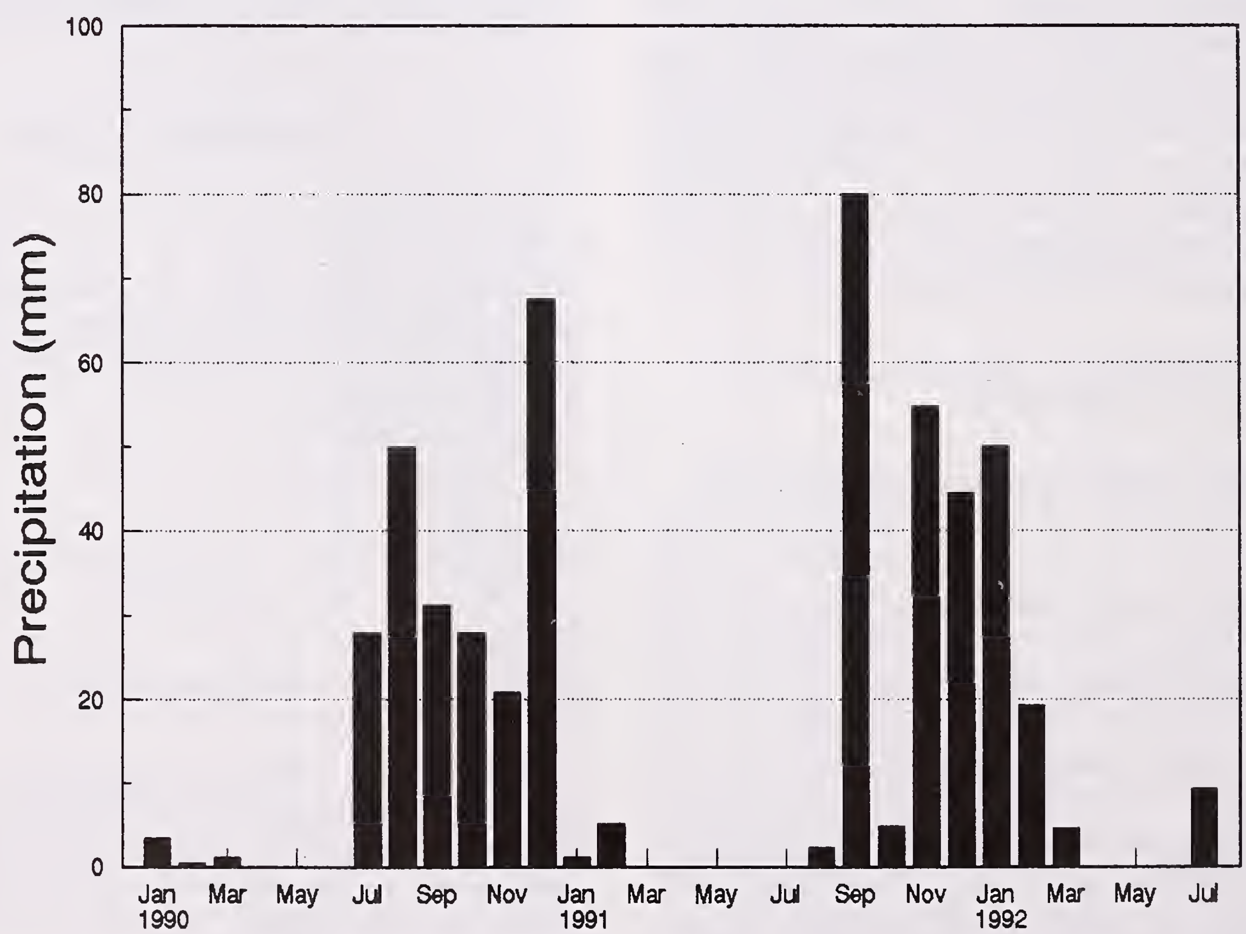

Figure 2. — Precipitation amounts (mm) measured at the Todos Santos Experiment Station during the course of the study.

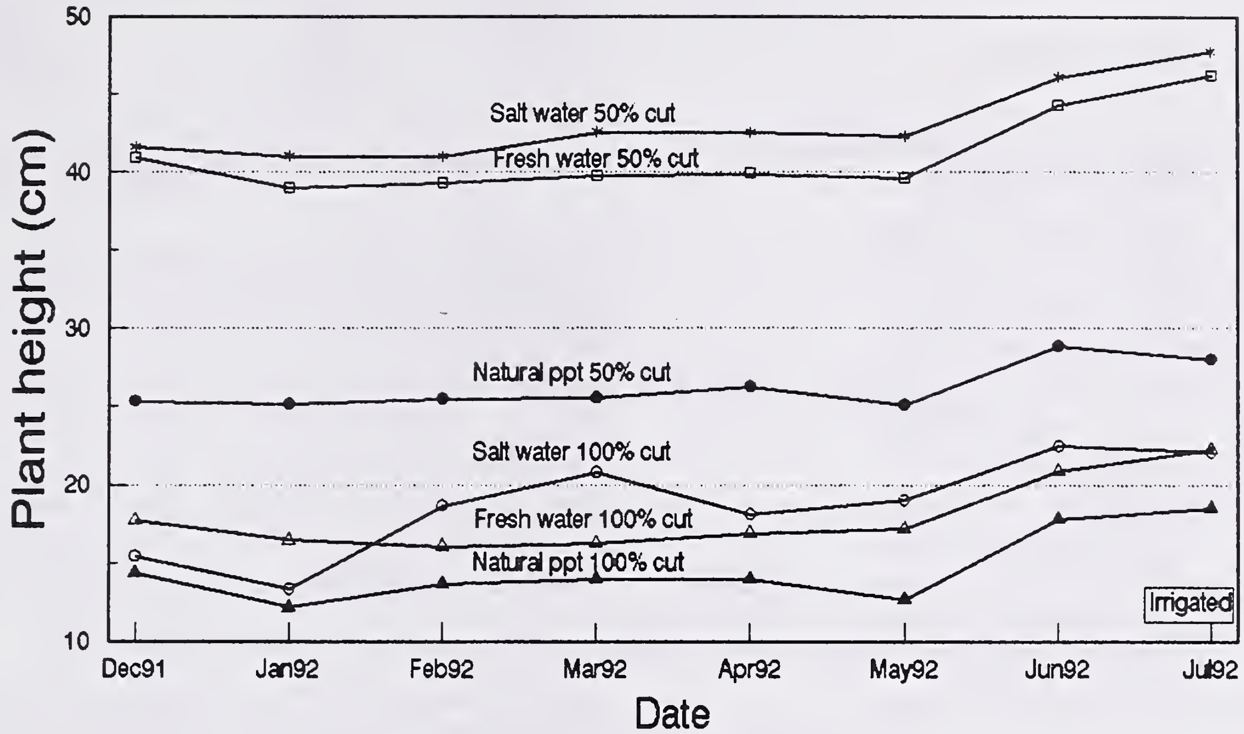

Figure 3. — Plant height (cm) of fourwing saltbush showing effects of three water regimes and two harvesting intensities. Data taken after the first harvest to the end of the study.

and saline watered plants averaged 82.61 cm (fig. 1). These values were not significantly different, but the plants grown with natural precipitation only were significantly shorter (52.06 cm) (P = 0.05). This would be expected since 2 irrigations (March and July 1991) had been applied and after December 1990 very little natural precipitation fell until 80 mm in September 1991 (fig. 2).

Between the first harvest and just prior to the second harvest treatment effects became evident (fig. 3). The 100% cut plants started smaller and stayed significantly smaller than those cut 50% (21.07 vs 41.12 cm) (P = 0.05). The irrigated plants were not significantly different (42.26 cm saline and 37.35 cm fresh) but were significantly taller (P = 0.05) than those growing under natural precipitation only (25.16 cm).

Plant Crown Diameter

Plant crown responses were similar to those for plant heights. After a small growth increment in the month following transplanting, crowns remained stable until June of 1991 when branching began (fig. 4). Just prior to the first cutting, there were no differences in average crown diameter due to irrigation (saline water 101.08 cm and fresh water 93.80 cm), but these crowns were significantly larger than crowns on plants with natural rainfall only (69.01 cm) (P = 0.05) (fig. 4).

After 9 months regrowth, crowns were significantly larger on plants cut at 50% (59.47 cm) than those cut 100% (37.11 cm) (fig. 5). There were no significant differences between the saline and fresh water irrigation treatments, but these crowns were larger than those receiving only natural rainfall (fig. 5).

Plant Biomass

Green weights of crowns were significantly different between the 50% and 100% cut after the first cutting (October 1991) (Table 1). The effect of the irrigation treatment showed no significant difference (P = 0.05) between the saline and fresh water treatments. However, the biomass produced from natural precipitation (no supplemental irrigation) was less than half that from irrigation treatments (Table 1).

Dry weights were 47% of green weights. The leaves and small branches represented between 40% and 50% of total dry weight, and large branches contained 50% to 60% of the total. Only green weights were used for subsequent analysis.

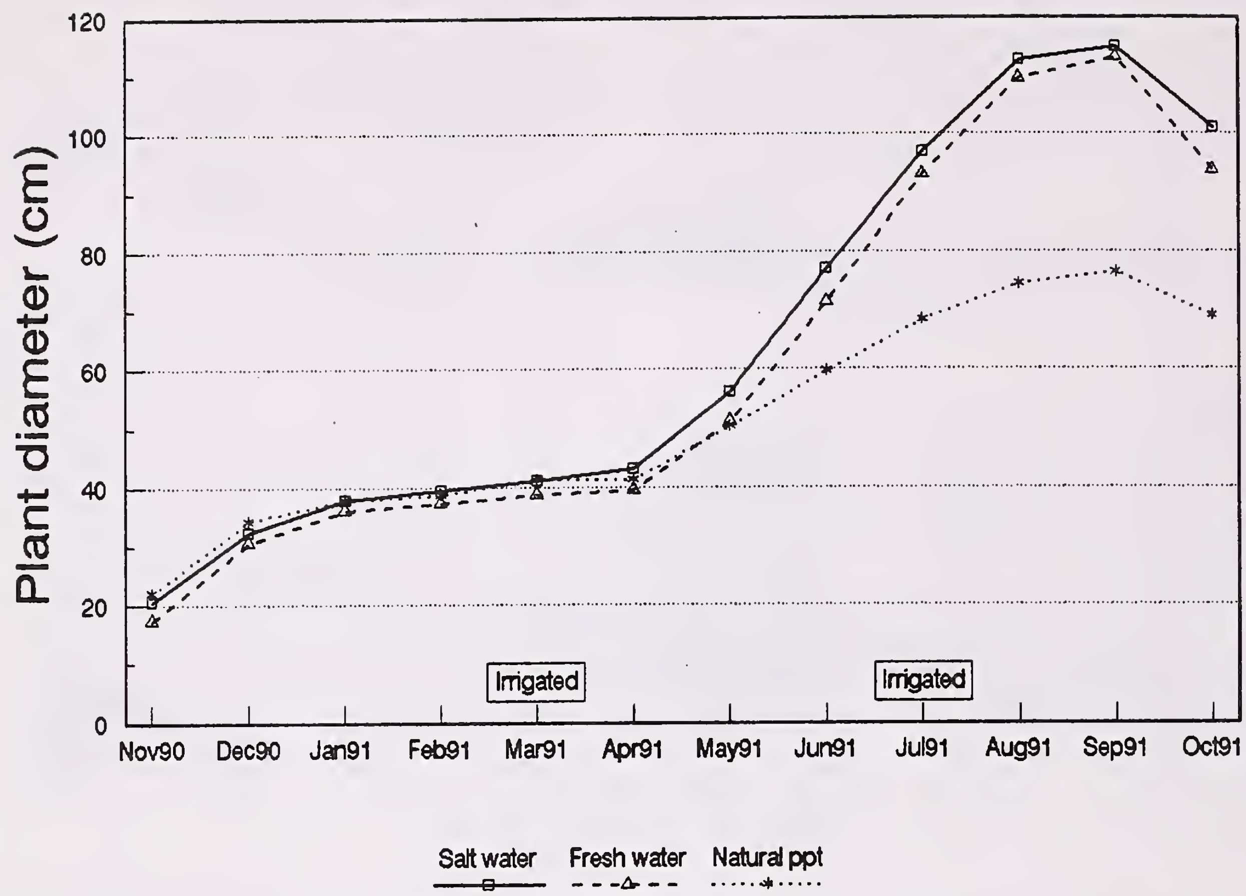

Figure 4. — Average crown diameter of fourwing saltbush grown under three water regimes, from planting to the first cut.

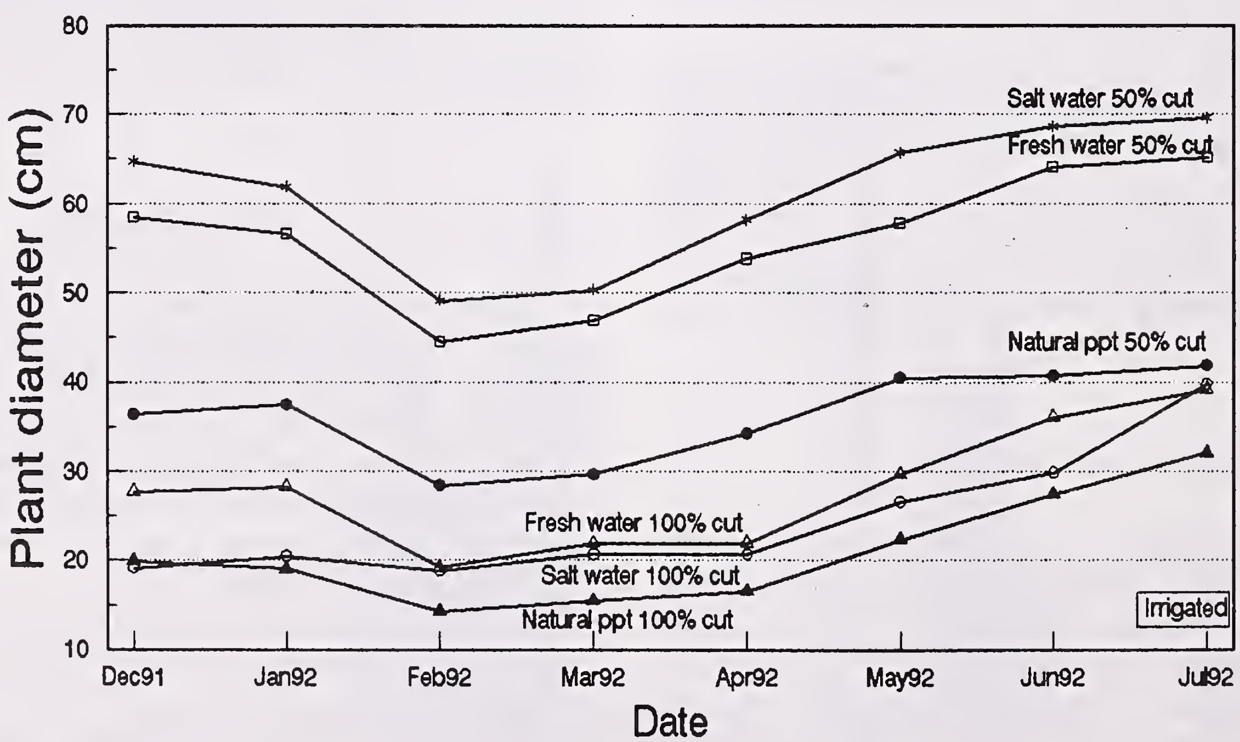

Figure 5. — Average crown diameter of fourwing saltbush showing the effects of three water regimes and two harvesting intensities. Data taken after the first harvest to the end of the study.

Table 1. — Green weights (kg/plot [144 m^2]) of fourwing saltbush crowns from three irrigation treatments and two levels of crown removal after the first harvest.

Treatment	Green Weight 50% Crown Removal	100% Crown Removal	Average
Saline water	48.31 a[1]	71.52 a	59.91 a
Fresh water	50.17 a	75.82 a	62.99 a
Natural ppt.	15.81 b	35.46 b	25.63 b
Average	38.09	60.93	

[1]*Numbers followed by the same letter in a column are not significantly different at the 5% level.*

Much less biomass was harvested in the second cutting (August 1992), done 10 months after the first regardless of treatments (Table 1 and 2). Results were less clear than after the first cut, however. At the second cut, the 50% cut had significantly ($P = 0.05$) more (6.28 kg) biomass than the 100% cut (1.38 kg) (Table 2). The irrigations were no longer more productive than natural precipitation (Table 2). Plants were irrigated only once (July 1992) between the first and second harvests, which may account for the lack of irrigation effect.

Table 2. — Green weights (kg/plot [144 m^2]) of fourwing saltbush crowns from three irrigation treatments and two levels of crown removal after the second harvest.

Treatment	Green Wt. 50% Crown Removal	100% Crown Removal	Average
Saline water	9.24 a[1]	1.51 a	5.37 a
Fresh water	6.54 a	1.68 a	4.11 ab
Natural ppt.	3.05 b	.94 a	1.99 b
Average	6.28	1.38	

[1]*Numbers followed by the same letter in a column are not significantly different at the 5% level.*

Plant Mortality

Plant mortality was measured at the end of the study (August 1992). Plants with crowns harvested at 50% varied from 4% to 14% mortality. Plants with crowns harvested at 100% suffered 66% mortality. Mortality was not significantly different ($P = 0.05$) due to irrigation treatment. Termite activity was noted at the base of many of the plants harvested at 100%. It is not known how much these insects contributed to mortality.

Soil Salinity

As might be expected, soil salinity increased on plots irrigated with saline water (Table 3). At the 0-30 cm soil depth, the three irrigations caused salinity to increase (E.C. = 698 to 4580 mmohs cm^{-1}). At the 30-60 cm depth, E.C. values from 2062 to 5320 mmohs cm^{-1} were measured at planting and after the third irrigation.

Table 3. — Changes in soil salinity (mmohs cm^{-1}) on plots irrigated with saline water.

Soil Depth	At Planting (Oct. 1991)	After Irrigation (March 1991)	(July 1991)	(July 1992)
0-30 cm	698	1250	4540	4580
30-60 cm	2062	2130	4500	5320

DISCUSSION

Findings from this study suggest the following:

1. If a minimum number of irrigations are used, saline water can be used to establish and maintain growth of transplanted fourwing saltbush seedlings.
2. When most of the crown of these plants is harvested, severe mortality results regardless of irrigation.
3. If plants with crowns completely harvested do survive, their growth will be severely reduced. Lighter crown removal (50%) does not have such severe affects.
4. When saline water is used for irrigation, minimum amounts should be applied to avoid toxic build-up in the soil.

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Ecological Restoration of Southwestern Ponderosa Pine

W. Wallace Covington, Margaret M. Moore, and Peter Fule[1]

Abstract — Major ecological changes have been observed in the ponderosa pine forests of northern Arizona since settlement by Americans of European descent approximately 120 years ago. Exclusion of the frequent, low-intensity fires characteristic of presettlement forests has led to great increases in tree density and forest fuels with concomitant decreases in herbage production and water storage. We are applying a restoration treatment consisting of postsettlement tree cutting, excess forest floor removal, and prescribed burning on a 5 ha site to restore the presettlement forest structure and ecological processes. One third of the site will remain as an untreated control, one third will receive restoration of forest structure only, and one third will receive the full restoration treatment. Over the 20-year span of the study we will measure tree growth, understory production, nutrient cycling, fuel accumulation, and wildlife habitat changes.

PRESETTLEMENT PONDEROSA FORESTS

The Mogollon Plateau, stretching across central and northern Arizona, supports a nearly pure forest of ponderosa pine (*Pinus ponderosa* Laws.) at elevations of 2100 to 2600 meters. Prior to settlement of northern Arizona by Americans of European origin, around 1870 to 1880, the forests were dominated by large, mature trees. In his 1960 analysis of forest change, Charles Cooper quoted the account of the early explorer Lt. Edward Beale: "A vast forest of gigantic pines, intersected frequently with open glades, sprinkled all over with mountains, meadows, and wide savannahs, and covered with the richest grasses...It is the most beautiful region I ever remember to have seen in any part of the world."

The open forest was maintained by frequent surface fires sparked by the region's dry climate and intense lightning, with fire return intervals ranging from 2 to 12 years (Weaver 1951a, Swetnam 1990). Mature ponderosa trees are well-adapted to surface fire due to their thick, insulating bark and clean boles (Biswell 1972). Distinct patches of trees existed in the grass matrix; these may have been maintained by occasional complete burning of dead and down logs, killing the surrounding grass and leaving a prepared seedbed (White 1985).

CHANGES SINCE SETTLEMENT

Dramatic changes occurred rapidly upon settlement. Cooper (1960) and many others (e.g., Weaver 1951b, Moir and Dieterich 1988, Barrett 1988, Covington and Moore 1992) have described these changes primarily due to the introduction of vast numbers of domestic animals that consumed the herbaceous understory, breaking the fuel continuity and effectively excluding fire from the ecosystem. Organized fire suppression efforts by the Forest Service maintained the exclusion. Without fire and herbaceous competition to control regeneration, dense seedling patches became established in forest openings. Loss of grass cover led to erosion and cutting of arroyos. As plant production shifted from herbaceous to woody plants, deep forest floors of slowly-decomposing litter accumulated. Together with the fuel ladder created by young, dense stands, these fuels supported crown fires, which were previously unprecendented in ponderosa pine. Projecting these trends into the future implies continued ecosystem degradation, stagnant growth, and increasing susceptibility to fire, insects, or disease (Covington and Moore 1992).

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RESTORATION PROJECT AT THE GUS PEARSON NATURAL AREA

We have initiated a restoration ecology project to emulate, as closely as possible, the presettlement ponderosa pine forest structure and fire disturbance pattern. Our intensive study site is approximately 3 ha at the Gus Pearson Natural Area in the Fort Valley Experimental Forest, 15 km northwest of Flagstaff, Arizona. This Experimental Forest was the first set aside in the USA and the Natural Area has been preserved except for fire exclusion and an early management policy of cutting snags. Companion studies are being implemented at other sites in Arizona, Utah, and New Mexico. These studies are designed to establish benchmarks for a healthy ecosystem and maintain biodiversity within a cultural landscape.

To define the current forest conditions on the site plus an adjacent 1.8 ha control area, we made a complete inventory in 1992 of live and dead trees, downed trees, and stumps, recording location, diameter, species, and condition. Ages were determined for all presettlement trees and those near presettlement age, as evidenced by size, form, and the yellow bark color, as well as for 5% of the remaining trees. Figure 1 is a canopy view created by projecting crown dimensions from diameter (McTague 1988); it shows the patchy aggregations and larger size of the presettlement trees and the dense postsettlement clusters. Currently there are 3098 trees/ha at the site, mean diameter is 8.4 cm, and basal area is 34.5 m^2/ha.

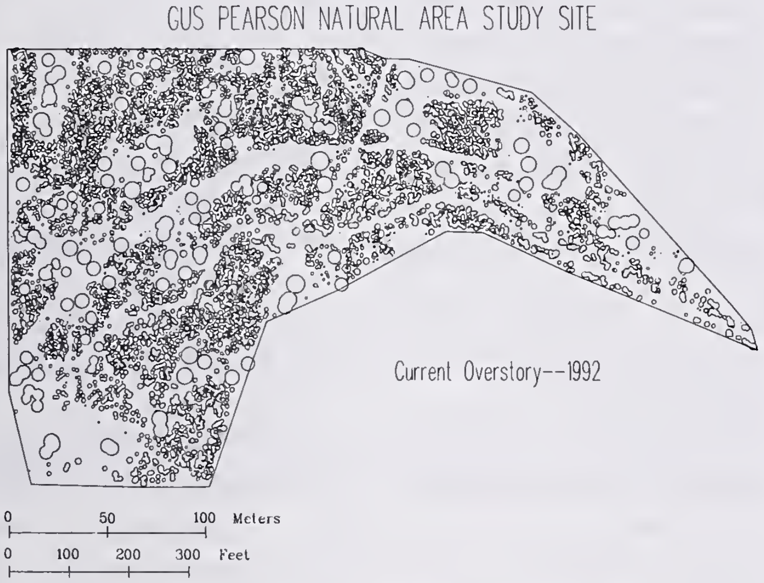

Figure 1. — Overstory structure in 1992.

Figure 2 shows the presettlement forest structure on the same site. Crown dimensions are still projected for the live presettlement trees, while the locations of presettlement snags, stumps, and downed dead trees are also indicated. We chose 1876 as the date of settlement because it is the last fire year determined by a fire history study at nearby Chimney Spring (Dieterich 1980). Characteristics of the 1876 forest were estimated by measuring diameter increment of live presettlement trees and applying decomposition rates to dead trees (Cunningham et al. 1980, Rogers et al. 1984). Making assumptions about the date of tree deaths and taking the 50th percentile of all modeled rates, the estimated 1876 forest had approximately 60 trees/ha, a mean diameter of 40 cm, and basal area of 10 m^2/ha. While estimates will vary depending on the modeling assumptions, these characteristics are 1 to 2 orders of magnitude different from those of today. Further refinement of the presettlement forest estimates will occur following planned dendrochronological analysis of stumps and downed trees.

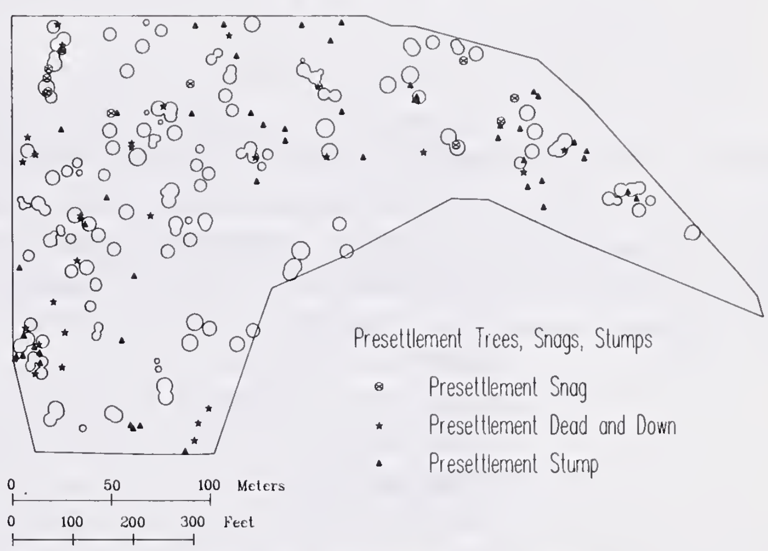

Figure 2. — Presettlement structure.

The ecological restoration treatment to be carried out in 1993 is designed to restore forest structure by removing most of the postsettlement trees and the accumulated forest floor material. Native grasses will be loaded on the site to provide continuous fuel and a seed source, then fire will be re-introduced at presettlement intervals. The full treatment will be applied on 1/3 of the total 4.8 ha site. Another third will receive structural restoration but with continued fire exclusion, and the final third will remain untreated. The cutting pattern for restoration preserves all the living presettlement trees and was designed to recreate the 0.125 to 0.25 ha patches of the presettlement forest (Fule et al. 1993, Cooper 1960). Criteria for retention of trees included an estimate of fire survivability and spatial relationship to live and dead presettlement trees. The cutting pattern is shown in Figure 3, where the untreated control area is in the northwest corner of the site.

Baseline ecological measurements included herbaceous production by grasses and forbs, forest floor loading and bulk density, fuel loading, and soil nutrient content. These characteristics will be re-measured over the 20 year study, as well as detailed physiological examination of the response of presettlement trees to the thinning and burning, aboveground and belowground net production, and dynamics of nutrient and detritus processing.

Restoring natural structures and processes to a ponderosa pine ecosystem offers the hope of reversing some of the ecological degradation observed since settlement.

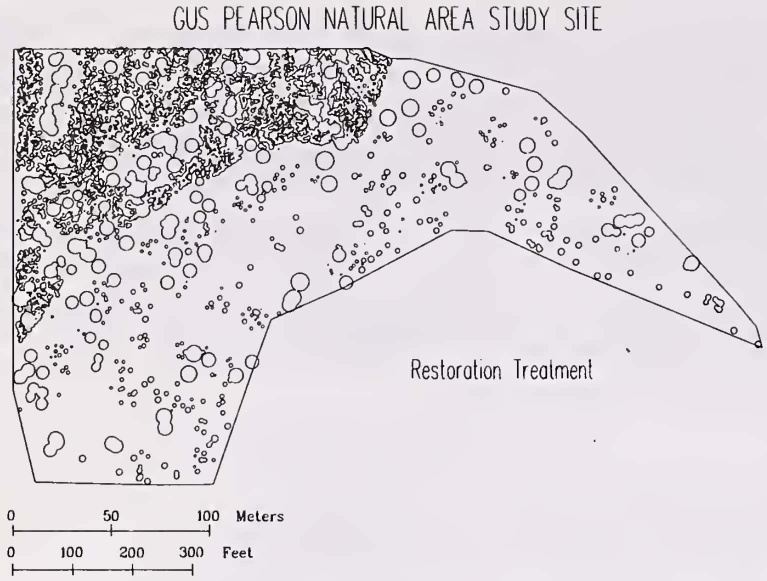

Figure 3. — Restoration cutting pattern; control area at upper left.

While a great deal of change has occurred and the future holds the possibility of global climatic alteration, an ecosystem under natural conditions of vitality is probably best equipped to meet these challenges.

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Monitoring Forest and Rangeland Ecosystems to Make Sustainability Operational

Ward W. Brady[1], Earl F. Aldon[2], and John W. Cook[3]

Abstract — The purpose of monitoring is to detect change. To implement a monitoring program without knowledge of error rates is at best risky and at worst may doom efforts at achieving sustainability. If monitoring designs are truly intended to provide information to make sustainability operational, then it is imperative that the consequences of errors be identified and appropriate levels of risk assigned. The **SUPERB** decision support system (DSS) was developed to provide a tool to assist in planning monitoring designs to ensure that good data are collected. A **SUPERB** monitoring design would be **S**table (assigned Type-I error would result in an acceptable rate of falsely concluding change), **P**owerful (actual Type-II statistical error would result in an acceptable probability of failing to detect true change), **R**obust (monitoring data would be not biased by extraneous factors) and **B**udgetarily sound (would meet these three criteria within cost constraints).

Sustainability, now more than ever, is an essential goal of resource management. Resource management decisions ought to enhance the sustainability of our forest and range ecosystems. Monitoring plays a crucial role in the quest for sustainability by providing the information on change in ecosystem structures or processes that managers need to make decisions. If good monitoring information is available, then managers have a powerful tool for choosing management alternatives which enhance ecosystem sustainability. Conversely, if monitoring does not produce good information, then unwise decisions may result and sustainability may suffer. The objective of our paper is to discuss what constitutes good monitoring information and introduce a computer-based decision support system that will help determine the adequacy of a monitoring design for natural resource management needs. In particular, our focus is on the concept of what constitutes a "good monitoring design", not on what components of an ecosystem should be monitored to meet specific ecological or management objectives nor on what specific methods should be used to collect data.

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MONITORING DESIGN REQUIREMENTS AND RISKS

Ecological or Management Importance

Following selection of the ecosystem component to be monitored, what constitutes important change in that component must be clearly specified. Importance, in this context, may have multiple meanings and should be conceptually linked to the consequences of change. For instance, if the goal in monitoring is to detect change in basal area of grasses on watersheds being grazed by livestock, a decrease in basal area (of a specified magnitude e.g. from 15% to 10%) may have great *ecological* importance because of increased risk of soil erosion. This same decrease will also have *management* importance in that it may result in removal of livestock from the watershed. Increases in basal area (again of a specified magnitude) would also be important to the extent that they influence management decisions. The monitoring design must clearly specify what

constitutes important change ("*desired-detectable-change*", fig. 1) if estimates are to be made of the likelihood of detecting that change (i.e. statistical significance).

I. DETERMINE ECOSYSTEM COMPONENT TO BE MONITORED AND MONITORING METHODS

II. CHARACTERIZE MONITORING DESIGN REQUIREMENTS AND RISKS

1. Define magnitude of change that is important from an ecological or management perspective: *desired-detectable-change*

2. Describe consequences of falsely concluding change and quantify risks of these errors (Type-I error rates): *desired-stability*

3. Describe consequences of failing to detect change and quantify risks of these errors (Type-II error rates): *desired-power*

III. PROTOTYPE THE MONITORING DESIGN USING COMPUTER SIMULATION

Simulate proposed monitoring methods

Simulate ecosystem component to be monitored

Evaluate sensitivity and reliability of the computer prototype

IV. EVALUATE THE MONITORING DESIGN USING THE COMPUTER PROTOTYPE

Desired-detectable-change: set by monitoring design.

Desired-Stability: set by monitoring design.

Power: does the design detect change at a rate less than or equal to the *desired-power*?

Robustness: does the design give biased answers under expected conditions?

Budgetarily Soundness: can the design be implemented given available budgets?

V. IS THE MONITORING DESIGN SATISFACTORY?

Yes: Implement the Monitoring Design

No: Modify either the Monitoring Methods (step I) or Monitoring Design Requirements or Risks (step II) as needed and repeat steps III and IV until a satisfactory monitoring design is found.

Figure 1. — Five major steps occur in the SUPERB Decision Support System for planning or evaluating a monitoring design. A SUPERB monitoring design would be Stable (assigned Type-I error would result in an acceptable rate of falsely concluding change), Powerful (actual Type-II statistical error would result in an acceptable probability of failing to detect true change), Robust (monitoring data would be not biased by extraneous factors) and Budgetarily sound (would meet these three criteria within cost constraints).

A crucial distinction must be made between ecological and/or management importance and statistical significance (Yoccoz 1991, EPA 1992). Ecological and management importance are both conceptually related to the risks associated with change in an ecosystem. Statistical significance defines error rates associated with detection of that change.

Statistical Significance

All monitoring designs will, on occasion, produce data which result in a false conclusion that changes in the ecosystem have exceeded *desired-detectable-change*. Such false conclusions are termed Type-I statistical error and could either initiate unnecessary management action or delay needed management response. The monitoring design, therefore, must incorporate both the ecological or management consequences of false conclusions of change and the acceptable probability of making such errors. The monitoring design process requires that several questions be answered. Using our previous example, we must first ask what are the consequences of incorrectly concluding that basal area of grasses has decreased on the watershed? Then based on these consequences we must decide how often it would be acceptable to make this error. Next we must ask what are the consequences of incorrectly concluding that basal area has increased on the watershed? And based on these consequences we must again decide how often it would be acceptable to make this error. Note that the consequences of these errors are not necessarily equal. For instance, the manager might be willing to accept a 1 in 20 (0.05) chance of incorrectly concluding basal area has increased, but only a 1 in 100 (0.01) chance of incorrectly concluding basal area has decreased. This assumes that the consequences of a false conclusion of an increase in basal area are less serious than the consequences of a false conclusion of a decrease in basal area. Together these errors describe the acceptable Type-I statistical error for this monitoring problem (Tanke and Bonham 1985, Ostle 1969).

Monitoring designs also may err by leading to false conclusions of no change (i.e. Type-II statistical error, the failure to detect true change). Again several questions must be asked to determine both the ecological or management consequences of an error and the acceptable probability of making such an error. Using the previous example, what would be the consequences of concluding no change when, in fact, a decrease in grass basal area had occurred? Would it be acceptable if the monitoring design had a 1 in 20 (0.05) chance of making this error (equivalent to a 95% chance of detecting the change)? What would be the consequences of concluding no change when an increase in basal area had occurred? Would it be acceptable if the monitoring design had a 1 in 10 (0.10) chance of making this error? The ecological consequences of failing to detect an increase or

decrease in basal cover are not necessarily equal, therefore, the risks assigned to these consequences (the acceptable probability of making the error) are not necessarily equal either. These errors describe Type-II statistical error (Tanke and Bonham 1985, Ostle 1969).

Type-II error is a function of acceptable risk of a Type-I error, precision of the sample (a function of sample size) and desired-detectable-change (Brady *et al.* 1990, Sokal and Rohlf 1981). Therefore, Type-II error can be reduced by accepting a larger risk of Type-I error, collecting larger sample numbers (or better samples), or increasing the *desired-detectable-change* (e.g. accepting a 20% change in mean basal area rather than a 10% change). A determination of Type-II error is often omitted because of the complexity of calculations, however, for most ecosystem monitoring problems it is of prime importance. The purpose of monitoring is to detect change. To implement a monitoring program without knowledge of Type-II error rates is at best risky and at worst may doom efforts at achieving sustainability. If monitoring designs are truly intended to provide information to make sustainability operational, then it is imperative that the consequences of Type-II errors be identified and appropriate levels of risk assigned.

THE SUPERB DECISION SUPPORT SYSTEM FOR MONITORING

The **SUPERB** decision support system (DSS) was developed as an effective tool that natural resource managers can use when planning monitoring designs to ensure that good data are collected (fig. 1). A **SUPERB** monitoring design would be Stable (assigned Type-I error would result in an acceptable rate of falsely concluding change when nothing has happened), **P**owerful (actual Type-II statistical error would result in an acceptable probability of failing to detect true change), **R**obust (monitoring data would not be biased by extraneous factors) and **B**udgetarily sound (meets these three criteria within cost constraints) (Green 1979, Smathers *et al.* 1983, Brady *et al.* 1990, Colinvaux 1991). Computer simulation models of both the target population and monitoring design are used by the **SUPERB** DSS to evaluate whether design objectives can be achieved.

Following selection of the ecosystem component to be monitored and the proposed sampling method, the **SUPERB** DSS begins by requiring selection of levels of *desired-detectable-change* (fig. 1). Next, the ecological and management consequences of falsely concluding *desired-detectable-change* (either an increase or a decrease) are described. Based on these consequences, acceptable probabilities for making these errors are chosen (Type-I error) and the *desired-stability* properties of the monitoring design are defined (fig. 1). Likewise, the ecological and managerial consequences of failing to detect *desired-detectable-change* (either an increase or a decrease) are described. Based on these consequences, acceptable probabilities for making these errors are chosen (Type-II error) and the *desired-power* properties of the monitoring design are also defined (fig. 1).

Using computer simulation, the **SUPERB** DSS then evaluates the likelihood of the monitoring design successfully detecting the *desired-detectable-change* given the chosen *desired-stability* properties (a function of Type-I error rates) and *desired-power* properties (a function of Type-II error rates) of the monitoring design (fig. 1). These same simulations also can be used to test for the presence of confounding factors (an evaluation of *robustness*, fig 1) and to evaluate the costs of the monitoring design (*budgetary soundness*, fig. 1).

If the chosen monitoring design is **SUPERB**, then it can be implemented with some assurance that good monitoring data can be obtained. On the other hand, if the design is flawed, then the **SUPERB** DSS will present the manager with options to make the design more effective. *Power* and *budgetary* problems can be addressed by modifying monitoring methods (e.g. increasing sampling precision), reducing *desired-stability*, and/or *desired-power* (i.e. increase either acceptable Type-I or Type-II error rates), or increasing *desired-detectable-change* (rethinking what magnitudes of ecosystem change are "important"). *Robustness* problems can be addressed by changing the monitoring methods. The evaluation procedure is then repeated until the most effective design is developed given available resources.

The advantage of using the **SUPERB** DSS is that planning prior to implementation of monitoring will help insure that monitoring supports the ultimate goal of sustainable forest and range ecosystems. Furthermore, such planning will help prevent costly implementation of poorly designed monitoring systems that are inadequate to meet management needs. Poorly designed monitoring systems may fail to forewarn managers of ecosystem degradation or they may fail to reflect improving conditions. Properly designed monitoring systems, on the other hand, will provide the data that land managers need to respond to changes in ecosystems and help insure that the management decisions which are made are wise decisions.

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Silvicultural Prescriptions for Sustained Productivity of the Southwestern Pinyon-Juniper and Encinal Woodlands

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Abstract — Pinyon-juniper and encinal woodlands cover extensive areas of the southwestern United States and northern Mexico. In the past, the tree cover on many of these lands often was eradicated to encourage forage production for livestock. Land managers are beginning to realize that the woodlands should be managed for sustained production of an entire range of resource values, including fuelwood, tree seeds, forage production, wildlife habitat, watershed protection, recreation, and non-traditional plant products. Silvicultural prescriptions can benefit several resources. Single-tree selection and two-step shelterwood methods appear to offer the best possibilities of sustained pinyon-juniper production, because they account for the dispersal characteristics and regeneration requirements of the dominant species. Coppice methods appear best for the oak-dominated encinal woodlands. Slash treatments in the woodlands can be modified to reduce soil erosion. Silvicultural recommendations based on experience and research in the United States may also be applicable to woodlands in Mexico, but prescriptions must be evaluated locally.

INTRODUCTION

Pinyon-juniper and encinal woodlands cover large areas of the southwestern United States and northern Mexico. The two woodlands often are contiguous and intermixed. They generally are associated with dry sites, although species composition, stand density, and development vary by elevation, topography and regional geography.

At one time, a primary management objective was to reduce tree cover in favor of forage production for livestock (Gottfried 1992). Currently, there is a growing realization that the woodlands can produce a range of valuable resources and amenities, and that they should be managed according to a multiresource philosophy. The woodlands are important to the culture and economic interests of many indigenous and rural populations whose concerns must be considered.

Silviculture is an important tool for achieving multiresource management objectives. Although stand treatments for sustained production of tree products and amenities are usually emphasized, silviculture can be used to enhance forage production, cover for wildlife and livestock, watershed condition, and recreational opportunities.

The objectives of this paper are to briefly describe the characteristics and uses of pinyon-juniper and encinal woodlands in the southwestern United States and northern Mexico, and to discuss how silvicultural methods can be used to enhance and sustain productivity for multiple resources. While most of the information is based on conditions in the United States, some of the information may be applicable to Mexican woodlands.

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SOUTHWESTERN PINYON-JUNIPER WOODLANDS

Distribution

Pinyon-juniper woodlands cover approximately 190,200 square kilometers in the western United States. The woodlands in the Southwest, which are characterized by the presence of Colorado pinyon (*Pinus edulis*), occupy about 17% of Arizona and 26% of New Mexico. Similar stands also occur in eastern Utah and Colorado. There are about 44,500 square kilometers of pinyon-juniper and pure juniper stands in Arizona; 88% of which are usable for growing wood products (Conner et al. 1990). Approximately 54% or 40,450 square kilometers, of New Mexican woodlands are considered as manageable according to density and quality criteria (Fowler et al. 1985).

The climate in the woodlands is classified as arid or dry sub-humid (Ronco 1990). In the Southwest, stands generally are found at elevations of 1,370 to 2,290 meters, where precipitation ranges from 305 to 560 millimeters annually. Pinyon forests in Mexico can be found at higher elevations, where precipitation is greater than in the woodlands of the southwestern United States (Segura and Snook 1992). The seasonal distribution of precipitation, particularly the relative amounts of winter and summer moisture, influences stand composition. The woodlands grade into grasslands, brushlands, and encinal woodlands on drier sites, and into ponderosa pine (*P. ponderosa*) forests on more moist sites. Woodlands are found on soils associated with different parent materials and characterized as being shallow, well-drained, and generally of low fertility, although exceptions occur.

Characteristics

Two-needled Colorado pinyon is the most characteristic pinyon of the woodlands of the Southwest (Gottfried 1992). Pinyons are slow growing but can survive for over 400 years (Ronco 1990). The three-needled border pinyon (*P. discolor*) is associated with the encinal woodlands of southern Arizona and New Mexico. The Mexican pinyon (*P. cembroides*) is widespread at lower elevations in the mountains of northern Mexico, (Critchfield and Little 1966) and in the rain shadows of the eastern and western Sierra Madre mountain ranges (Segura and Snook 1992). Mexico contains other pinyon species, such as *P. quadrifolia* and *P. nelsonii*, but the individual species generally are restricted to isolated locations (Critchfield and Little 1966).

Junipers (*Juniperus* spp.) are the other major tree group in the southwestern woodlands. The four major species are: one-seed (*J. monosperma*); Utah (*J. osteosperma*); alligator (*J. deppeana*); and Rocky Mountain (*J. scopulorum*). Stands can contain one or several of these species. Alligator juniper is a common component of some encinal stands and Mexican pinyon forests. The junipers generally are multiple-stemmed trees.

The average pinyon-juniper stand in the Southwest is uneven-aged and contain about 1,150 trees and 21 square meters of basal area per hectare (Barger and Ffolliott 1972). Pinyons are more common in a typical stand and tend to dominate in the smaller size classes, while junipers are an important component of the larger size classes and contribute almost half of the wood volume. Even-aged stands develop after disturbances such as fire and tree control operations for range improvement or agricultural activities. Segura and Snook (1992) studied an uneven-aged Mexican pinyon forest in the State of Veracruz, Mexico, and reported a stand density of 870 stems and basal area of 10 square meters per hectare.

Pinyon-juniper woodlands are not homogeneous. Moir and Carleton (1987) recognized at least 70 habitat types in Arizona and New Mexico. Available soil moisture is the most critical factor controlling the distribution of woodlands, and the composition and density on undisturbed sites. Junipers, which are more drought tolerant than pinyon, dominate on drier sites, but pinyons increase in importance as available moisture increases. The distribution of juniper species is influenced by the proportion of winter precipitation. Utah juniper occurs in winter moisture areas, while one-seed, alligator, and Rocky Mountain junipers dominate in summer moisture areas (Springfield 1976). Temperature extremes also affect the upper and lower elevational distribution of woodland species.

Uses

There is a growing recognition that the pinyon-juniper woodlands can produce a variety of resource products and amenities. Fuelwood harvesting historically has been an important activity. Demands for fuelwood in the United States increased dramatically following the oil embargoes of the 1970s. Woodlands are the main vegetative type on many southwestern reservations, and the sale of fuelwood is important to the economic health of these American Indian communities. In addition to fuelwood, trees are harvested for fenceposts, small dimension construction timbers, and Christmas trees. Pinyon nuts are a traditional product for commercial and personal consumption. Grasses, seeds from other species, and tree limbs also are gathered for consumption or for decorations and crafts (Huber 1992).

Spanish colonists introduced livestock into the ecosystem in the sixteenth century. Livestock numbers increased during the 1880s causing wide-spread range and site degradation. Livestock numbers have declined, but this industry is still important. Over 80% of the pinyon-juniper

lands in the western United States currently are grazed, and support between 1 and 1.5 million animal unit months of grazing (Evans 1988).

At one time, it was believed that removing pinyon and juniper trees would increase water runoff for downstream users. This belief was not supported by research in Arizona and in other locations (Clary et al. 1974). The low potential for water yield improvement is related to the high evapotranspiration demands within most of the ecosystem. Nevertheless, watershed management practices are necessary to reduce erosion, which will impact water and site quality and long-term site productivity.

Woodlands provide seasonal and year-round shelter and food for a large number of game and nongame species including some rare and endangered species. The woodlands are important for hunting and birding activities and also provide other recreational opportunities. Recreational demands have increased rapidly in recent years. Pinyon-juniper woodlands also contain high concentrations of important archeological and historical sites which must be protected during management activities.

Management Philosophies

The management philosophy towards the pinyon-juniper woodlands has been inconsistent over the last 100 years. Initially, they were viewed as having marginal value and treated with neglect. In the 1950s and 1960s, large areas of woodlands and savannas were cleared of trees in hopes of increasing forage for livestock and water yields. However, these operations generally were unsuccessful; in sustaining increases in forage production, increasing water yields, reducing erosion, and benefiting most wildlife. An economic analysis by Clary et al. (1974) found that even successful clearing operations only broke even.

There is growing interest and public demand for multiresource management that will create and maintain healthy and sustainable woodland ecosystems. However, there are differences of opinion of what constitutes a desired condition. At present, management goals and prescriptions vary throughout the Southwest.

Silviculture

One part of the definition of silviculture states that it is the application of a knowledge of silvics to the treatment of a forest or woodland (Society of American Foresters 1958). Silvics or tree ecology must serve as the basis for management activities if multiresource goals of sustainability and health are to be achieved. Managers must determine the mix of resources to be favored on a site and modify their prescriptions accordingly. One key objective is to ensure adequate tree regeneration for the future. Although knowledge of pinyon-juniper woodland ecology is increasing, it still is incomplete (Gottfried 1992). However, managers recognize that heavy, wingless seeds of pinyons and junipers, and dryland environmental conditions (Gottfried 1987) require special consideration when preparing silvicultural prescriptions. It would be ideal if treatments could be linked to good seed crops, but this is difficult considering the relatively long period between good years, and the inability to confidently forecast them. Silvicultural prescriptions must be linked to habitat type in order to succeed.

Bassett (1987) in reviewing the potential applicability of common silvicultural prescriptions to the woodlands, concluded that single-tree selection and two-step shelterwood methods best sustain stand health and productivity for tree products or for a mix of resources. These cutting methods are compatible with the dispersal patterns of heavy tree seed, provide protected micro-sites for regeneration, and are aesthetically acceptable. The single-tree selection method reduces stand density but still retains the uneven-aged structure and horizontal and vertical diversity important for some wildlife species. Initial harvesting by the shelterwood method which leaves the best trees for seed production also tends to retain a diverse cover. However, there are some disadvantages with both methods, especially related to the costs associated with intensive management and potential damage to residual trees during subsequent harvests. Bassett (1987) discussed the trade-offs that must be evaluated in preparing a silvicultural prescription. There are differences of opinion concerning diameter distribution and residual density goals following single-tree selection treatments. Different stand densities also can affect pinyon nut production, which is important for tree regeneration, and wildlife and human food. The possibilities of increasing pinyon nut crops by silvicultural activities also is being considered in Mexico (Segura and Snook 1992).

The Rocky Mountain Forest and Range Experiment Station and land management agencies in the Southwest are currently conducting research to develop and evaluate single-tree selection prescriptions. Group-selection, which creates small openings within the stand, is less common and needs further study. Success from a forestry perspective will depend largely upon achieving satisfactory regeneration from residual seedlings, and trees produced by seed which was present initially or fell or carried by animals into openings from the surrounding stand.

The shelterwood method is used to regenerate even-aged stands and can be used in existing even-aged and uneven-aged woodlands. Bassett (1987) recommended the two-step shelterwood method. A modified one-cut shelterwood method, which removes the entire overstory, can be used where advance tree regeneration is satisfactory. However, it is important to protect the younger trees from harvesting damage. Segura and Snook (1992) appear to be

recommending a simulated shelterwood to release small trees and advance regeneration in the Mexican pinyon forest in Veracruz.

The clearcut method, except where alligator juniper is common, and the seed-tree method generally result in unsatisfactory regeneration success because these cutting methods are not adapted for species with short seed dispersal distances. Small, dispersed clearcuts are appropriate when dwarf mistletoe (*Arceuthobium divaricatum*) control is necessary.

Current management is attempting to integrate livestock and wildlife with the tree production (Gottfried and Severson 1993). Silvicultural methods can also be used to enhance forage production for livestock and forage and cover for wildlife habitat. A common treatment is designed to clear small dispersed areas of trees. This practice has been shown to benefit elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) (Short et al. 1977). However, care must be taken to insure that openings are not too large (Severson and Medina 1983) or that the woodlands become too fragmented.

Wildlife and other needs must be assessed to ensure tradeoffs in resource allocation are acceptable. Openings create a more diverse landscape that should favor other wildlife species such as small mammals (Gottfried and Severson 1993). In many cases, the size of the openings may not be critical, if continuous corridors of adequate width are maintained. Managers must decide if cleared wildlife-livestock openings should be maintained or trees should be allowed to reoccupy the sites. If regeneration is vigorous and dense enough to result in a healthy stand of trees, the area should be allowed to recover, since successful regeneration of openings often is difficult. A management scheme could be created which would involve a variety of seral stands in space and time. This strategy would enhance biological diversity within woodland landscapes.

Treatments that reduce tree densities should benefit livestock and native ungulates by providing additional forage while maintaining some degree of thermal and hiding cover. However, the impacts of residual trees on understory dynamics are unclear. Some questions concern the quantity and quality of herbaceous vegetation which can be achieved and the longevity of any increases. Relationships among overstory cover, tree regeneration, and forage yields need better definition. Forage production should be stimulated in areas harvested according to the overstory removal cut of a simulated shelterwood and in group selection openings, although tree production is the eventual objective.

The management of slash created by harvesting activities is another concern. Several options are available, often within the same management unit (Gottfried and Severson 1993). Slash can be grouped into small piles and burned with a cool fire to stimulate seral plant species, or left for small mammal habitat. Strategically placed piles can provide a sense of security for wild ungulates by breaking up sight distances. It is generally agreed that large slash piles should not be burned, since this results in high losses of nitrogen and phosphorus and, therefore, lower long-term site productivity (Gottfried 1992). Alternatively, slash can also be scattered to provide protected regeneration niches for trees and herbaceous plants, and reduce erosion by slowing water movement and catching soil. Slash also can be piled in small gullies to reduce head cutting.

ENCINAL WOODLANDS

Distribution

Information on the distribution, characteristics, and uses of encinal woodlands has been obtained largely from Brown (1982), who reviewed nearly 1,000 references on biotic communities of the southwestern United States and northern Mexico. The encinals, also referred to as the western live oak type in the Society of American Foresters classification (Ffolliott 1980) and the Madrean evergreen woodland formation (Brown and Lowe 1980), are concentrated in the Sierra Madre Occidental of Mexico, from where they extend northward into southeastern Arizona, southwestern New Mexico, and Texas. Encinal woodlands cover approximately 80,300 square kilometers in aggregate, although a precise delineation of this biotic community is difficult, since inconsistent criteria for classification have been employed.

Annual precipitation in the woodlands exceeds 400 millimeters in general, of which 200 millimeters fall during the growing season of May through August. Extremes in annual precipitation range from 300 to over 1,000 millimeters. Freezing temperatures are rare in the southern portions of the woodlands but increase to an average of almost 125 days at the northern limits.

Encinal woodlands are found in the foothills, bajadas, barrancas, and sierras of the Sierra Madre Occidental and its outlying mountain ranges, and in the lower elevations of the mountain ranges in southeastern Arizona, southwestern New Mexico, and parts of Texas. The woodlands occur between 1,200 and 2,200 meters in elevation. Structural development of the encinals is apparently determined by soil type and depth. Stands commonly are located along drainages, on rocky slopes, and in other thin-soiled habitats. Patches of encinal species often are surrounded by subtropical deciduous forests, a mosaic pattern that is attributed largely to variations in soil type and elevations.

Characteristics

A large variety of oak species are found in the encinal woodlands of the Sierra Madre Occidental. Chihuahua oak (*Quercus chihuahuensis*) is commonly the first oak encountered at the lowest elevations in the southern parts of

the ecosystem. Mexican blue (*Q. oblongifolia*) is found at the lowest elevations to the north. Other evergreen oaks are Emory (*Q. emoryi*), *Q. albocincta*, and Arizona white (*Q. arizonica*). In addition, deciduous oaks, including *Q. chuchiuchupensis* and Santa Clara (*Q. santaclarensis*), are found in intermixture. Among the oaks in the mountainous regions of southeastern Arizona, southwestern New Mexico, and Texas are Emory, Arizona white, Mexican blue, and gray (*Q. grisea*). Silverleaf oak (*Q. hypoleucoides*) and netleaf oak (*Q. rugosa*) are found at the intermediate elevations. Pinyon and juniper species are found intermixed with the oak species on many sites throughout the encinals.

At its upper elevations in the southwestern United States, the encinals often grade into the interior ponderosa pine type. Northward, it can merge with the pinyon-juniper woodlands with complex transitional forms. In Mexico, encinal woodlands also grade into pine-dominated montane forests at higher elevations and into pinyon-juniper woodland communities.

Encinal woodlands contain relatively small, often multiple-stemmed, irregularly formed trees. Species compositions and stand densities depend largely upon specific site characteristics. One-, two-, or occasionally three-aged stand structures are found. Intermingled with these trees are shrubs, grasses and grass-like plants, forbs, and succulents, often in parks and savanna-like mosaics. Openness of the landscapes is related to soil properties, site characteristics, and history of land use.

Tree densities in the encinals vary considerably. The numbers of trees range from a few scattered individuals to several hundred stems per hectare. Volumes of stemwood vary from less than 2 to over 100 cubic meters per hectare (Ffolliott and Gottfried 1992). Annual growth rate is relatively slow, ranging from 0.25 to 0.50 cubic meters per hectare, an annual growth rate of less than 1 percent. Mortality generally is low, likely because the long history of utilization in some areas has reduced the number of over-mature trees (Conner et al. 1990).

There are 12 habitat types which are dominated by various encinal oak species (USDA Forest Service 1987). A predominant habitat type of the encinals in southeastern Arizona is *Quercus emoryi/Bouteloua curtipendula*. In addition, a general scarp woodland habitat type is recognized on sites with slopes in excess of 40 percent. Most of the encinal habitat types are associated with warm, dry or typical elevational subzones. There also are six habitat types in southern Arizona and New Mexico dominated by border pinyon, most of which contain some oak in the overstory or understory. These habitat types are associated with cool, wet or typical elevational subzones.

Uses

People use encinal woodlands to obtain fuelwood, fenceposts, and miscellaneous building materials. Demands for these wood products generally have been increasing in recent years. Forage for livestock production is important in many areas, although the woodlands have not been subjected to large-scale range improvement programs. Encinal communities are important habitats for many wildlife species. Big game species and some small mammals furnish hunting opportunities for many people, and an important non-consumptive use is viewing of diverse and often unique bird populations. Management of watersheds includes considerations of forestry, livestock production, wildlife habitat, recreational use, and soil and water resources. Protection of soil and water resources is particularly important because of the fragile nature of the soils and the limited amounts of available water.

Recreation and tourism collectively represent one of the largest income generators from encinal woodland communities. On-site recreational opportunities including hiking, camping, sightseeing, bird watching, and picnicking. Comprehensive statistics on the levels of these non-consumptive uses are incomplete (Conner et al. 1990). However, a growing number of people from both within and outside the region spend considerable time enjoying the unique woodland resources of the region. Relatively high concentrations of archaeological sites also are found in the encinal woodlands (Propper 1992).

Management Philosophies

Harvesting of wood products likely will continue to be a primary interest of people in the encinal woodlands (Ffolliott and Gottfried 1992). Inherently low levels of growth, irregular stem forms, and a lack of markets for commercially processed wood products constrain intensive development, however. Fuelwood and fenceposts undoubtedly will remain the primary wood products harvested. But livestock production, wildlife values, watershed considerations, recreation and tourism, and ongoing environmental issues have heightened pressures on managers to ensure that each of these other uses is given its due consideration. Management practices, therefore, are becoming more responsive to multiple values of encinal woodlands and people's desire for these multiple benefits.

Silviculture

Ecological research in the encinal woodlands which provides the basis for silvicultural prescriptions, is relatively limited (McPherson 1992). Acorn germination requirements have been investigated for Emory and white oak, and

establishment and initial growth rates have been reported for seedlings in several mountain ranges in southeastern Arizona (Nyandiga and McPherson 1992). It appears that natural regeneration from seed is episodic in nature, and, as a consequence, the encinals might not be reproducing in sufficient numbers to sustain themselves if they continue to be heavily harvested for fuel and other wood products (Borelli et al. 1993). Earlier studies in Arizona suggested that limited regeneration from seed can be attributed to livestock grazing (Phillips 1912) and summer drought (Pase 1969).

Vegetative reproduction by sprouting from roots and stumps has been observed to be an important regenerative mechanism (Phillips 1912, Borelli et al. 1993). On many sites, encinal stands sprout vigorously after cutting, indicating that coppicing might form a basis to obtain regeneration in silvicultural prescriptions. Furthermore, harvesting cycles can be reduced through proper thinning of the resultant coppice (Touchan et al. 1992). Sustainability of vegetative reproduction is unknown, however.

A silvicultural prescription for sustained productivity of fuelwood, based largely upon on the few studies mentioned above and management procedures of the USDA Forest Service in southeastern Arizona, might involve the following scenario. Trees to be harvested are marked for removal by those responsible for management (Bennett 1992). A subsequent thinning of the resultant coppice to retain 1, 2, or 3 of the largest and most vigorous residuals is scheduled for 5 years after harvesting. Delaying thinning beyond this time can reduce growth of the residuals (Touchan et al. 1992). Residual trees are selected for harvesting after they attain a specified size. For example, a diameter of 15 to 20 centimeters DRC (diameter at root collar) likely can be reached in 20 to 30 years after the coppice thinning on some sites. The USDA Forest Service specifies a 15-centimeter stump height and about a 45-centimeter slash height in southeastern Arizona.

Other silvicultural prescriptions based upon clearcutting, shelterwood, seed tree, and selection cuttings have been listed by the USDA Forest Service (1987) in their classification of habitat types. However, these silvicultural prescriptions have not been widely tested.

Removal of trees in any silvicultural treatment changes landscape diversity which can affect habitats for wildlife. Unfortunately, there have been no studies on the effects of harvesting in encinal woodlands on deer habitats (Smith and Anthony 1992) or those of other big game species, although an increase in diversity might be beneficial if sufficient cover is retained. Encinal woodlands provide resources for unique assemblages of neotropical migratory birds (Block et al. 1992), and it is likely that different management approaches will be needed for different situations. Actual impacts of silvicultural treatments on non-game bird and many other wildlife species remain to be evaluated.

Although livestock production is important, encinal woodlands have not been subjected to large-scale range improvement practices (Ffolliott and Guertin 1987, McClaran et al. 1992). Unpublished data indicate that production levels and species compositions of herbaceous plants might not be affected greatly by range improvement practices consisting of the removal of trees in fuelwood harvesting. A recent study by Haworth and McPherson (in press) found that an Emory oak canopy reduced the biomass of herbaceous vegetation but did not affect the distribution of herbaceous species relative to open grassland areas. However, more research is necessary to assess overstory-understory relationships over the broad range of sites found in the encinal woodlands (McPherson 1992).

CONCLUSION

The pinyon-juniper and encinal woodland ecosystems are important in the southwestern United States and northern Mexico. There is a growing realization and public demand for multiresource management of these lands. Woodlands, depending on habitat type and stand conditions, can produce: fuelwood; pinyon nuts, acorns and other edible seeds; small dimension construction products; forage for livestock; forage and cover for wildlife; watershed protection; and recreational opportunities. Silviculture is a primary tool for integrated resource management that can benefit several resources.

The woodlands of the southwestern United States and northern Mexico have similar characteristics, and similar silvicultural prescriptions may be applicable in both countries. However, prescriptions should first be tested locally. Single-tree selection and shelterwood methods appear to be best suited for regenerating pinyon-juniper stands, while the coppice method appears best to ensure regeneration of oak species within the encinal woodlands. Additional silvicultural options will be developed as new ecological and silvicultural information becomes available.

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Fire in the Tropical Pine Forests of Northeastern Nicaragua

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Abstract — Most of the forests in Nicaragua fall within the Region Autonoma Atlantico Norte. The forests are critically important because they serve as the best potential economic base for community development in most of this region. Over the last 10 years, 80 percent of this forest type has burned each year, destroying approximately 10 percent of the pine forest. The severe fire problem ranges from the area around Puerto Cabezas to the Río Coco on the northern border of the country. At the current rate of destruction, there will be no remaining forests by the year 2010. The development of a workable fire management program must be centered around a community strategy for reducing fire starts and preventing fire spread into unprotected forest lands by mechanisms which do not require more than modest investments of labor or economic resources. A system of "green breaks" - vegetative barriers of low flammability, could be installed in areas of high fire danger. This paper outlines the beginning of a program initiated by the Prescribed Fire Research Project in cooperation with the Nicaraguan Forest Service to develop such a system.

INTRODUCTION

The pine forests of the Miskito region of Nicaragua are located in the Autonomous North Atlantic Region (la Región Autónomia Atlantico Norte—RAAN) of the country. The 500,000 forested hectares are an important potential economic resource within the total area of 3.4 million hectares of mixed forest types. The pine region is sparsely inhabited but greatly impacted by human influences due to travel, grazing of livestock, and the frequent and extensive presence of wildfires in the dry season. These forests were high-graded and over-harvested during past decades by foreign companies, leaving poor quality forests and an impoverished population. Now the forestry situation in the region is critical as it can be developed to provide employment in the RAAN, buffering the economic crisis that the country is facing.

The RAAN's 180,000 inhabitants are principally (68 percent) native Miskito peoples. They are country people who live by subsistence agriculture along the banks of the largest rivers - Rio Coco, R. Prinsapolka, R. Bambana, R. Kukalaya, and R. Wawa - which flow through the region's 1.5 million hectares of tropical rain forest. The major obstacles to productive forest development and to increasing rural community development are intricately woven into forest management and use issues which conflict.

Miskito people practice traditional agriculture - clearing, burning, and cultivating their fields in the broad-leaf gallery forests that transition into pine forests as soil quality deteriorates with distance from the alluvium. Fires set for land clearing often escape from agricultural areas resulting in large fires that extend into the pine forests. There is no sense of economic ownership or other intrinsic value among the community people for the pine forests and fires are often set indiscriminately. Forest quality is further degraded or retarded and the forests are kept in a state unsuitable to provide economic incentives for protection of the resource. The problem becomes cyclic. The forests are exploited without management, the forest fires are constant, and the eastern population suffers from 90 percent unemployment. The forest operations are characterized by low budgets, small

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staffs, and extensive areas with poor access. As our associate one day remarked, "If there's a truck—there's no gas; if there's gas—there's no bridge...".

In 1960 the Northeast Forestry Project (PFNE), financed by FAO, was initiated with the principal objectives of reforestation, fire protection, and restoration of economic productivity. This project administered an area of 304,000 hectares of pine savanna, of which 70 percent was deforested. It constructed lookout towers for fire detection, employed forestry crews for fire control, and provided for environmental education of the rural population. Fuel breaks were installed in sectors that were strategic to fire control. After 32 years the PNFE has restored 180,000 hectares of forest ranging from 10 to 30 years.

One hope for the pine forests in the Miskito region is that Caribbean pine *Pinus caribaea* has the capacity to survive and grow after fire. But, losses in growth and development after fires are unknown. Caribbean pine can achieve heights up to 40 meters on better sites with a crown length of 30 to 40 percent of its height. In the RAAN, however, crown lengths of less than 20 percent are common as a result of crown scorching by wildfires. Much experience exists in fighting forest fires in Nicaragua, but very little knowledge exists on fire ecology or fire effects, and even less on fire danger and fire behavior prediction.

Climate

The RAAN is typically humid and tropical, but is influenced by the cooling effects of offshore marine influences. The mean maximum and minimum temperatures are 30° and 22° centigrade, and the mean annual precipitation is 3,000 millimeters that occurs between June and November. Even during the dry period, the precipitation is rarely less than 30 millimeters in any given month, and may be as high as 60 millimeters. From the end of May to the beginning of November, the rain exceeds 250 millimeters per month. After November, the rain diminishes, and masses of cold air from the north constantly descend over the region.

Topography

The entire zone is flat to smoothly undulating and gradually rises from sea level toward the west reaching 200 meters in some places. The principal drainage is from west to east, with other secondary drainage systems forming a dendritic structure, frequently with small U-shaped gullies. There is a relative abundance of marshes that increase in size and frequency accordingly as one advances toward the east.

Soils

The basic soil is a lateritic alluvium of granitic origin: it is a sandy clay silt, of brownish orange color, acid (pH of 4 to 5), and poor in nutrient elements as the depth increases to a meter or more. There is an A-horizon of clayey silt in zones of larger vegetation, but frequently this A horizon is nonexistent in zones that have been exposed to fire and weathering. Gravel pavements consisting of various proportions of quartz and iron concretions cover the surface to depths of several centimeters.

There are five principal horizons: black organic material; sand and freely draining silt; pure plastic argillic clay; sandy clayey silt; and hardpan. The black organic material is found to a depth of 30 centimeters in zones that are flooded during various months of the year. The A horizon can be totally or partially occupied by sand or sandy silt. Frequently, there is gravel on the surface. Nevertheless, except for well drained depressions, or near rivers, its depth is rarely greater than 20 centimeters. In poorly drained depressions, one finds a layer of sandy clayey silt, which is frequently covered by a layer of black organic matter and other leached sand. In general, the layer immediately below is hard. Normally it is of grayish blue color, but at times is a reddish brown color.

The principal soil of the whole zone is constituted by a sandy clayey silt that contains gravel. There exists everywhere a layer of iron cementations resistant to hand drilling. In poorly drained depressions, this layer is as deep as one meter, but in other places it is meters deep and can be seen in road cuts, eroded gullies, and the banks of the larger rivers. In a few places, a layer, various meters thick, of a fine white material resembling pumice, is found in relatively small zones. In those soils, gullies have clearly defined sides and vertical mud formations.

Vegetation

The RAAN is generally covered with an understory mixture of true grasses and sedges (*Cyperaceae*). The most sandy soils with best drainage are covered only with true grasses, and the poorly drained areas only with *Cyperaceae*. In areas where drainage is quite bad, the *Cyperaceae* is found in large well spaced tufts. These tufts invariably indicate the presence of water-logged plastic clays below the soil surface.

The presence of one of the sedges, a *Bulbostilus* species, depends to a large degree on the frequency of fire. It disappears in places that have been protected during various years, but in areas with frequent fires, its presence is related to the existence of iron concretions in the soil.

Fire is also believed to maintain the pine savannas in a sub-climax association. While the fire ecology of the tropical pine regions is not well understood, the pines are native and believed to be naturally occurring on these sites. The broad-leaved species are limited in frequency and growth

because of fire damage which masks their true potential. The common broad-leafs are: nacite (*Byrsonima crassifolia*), lengua de vaca (*Curatella americana*), roble (*Quercus oleoides*), and a large number of *Malastomaceae* species. Of these, the roble (oak) is the most important—it is highly flammable and it is the alternate host for the cone rust (*Cronartium* spp). The gallery forests, which contain many trees with high wood value, are found along the principal rivers and many secondary rivers. Palm trees are found in the bogs.

CONSIDERATIONS FOR THE ESTABLISHMENT OF GREEN FUEL BREAKS

At this point, critical research is needed to identify the best tree and shrub species that may function to restrict the spread of fire into forested areas, and to resprout or revegetate burned over areas.

By carrying out tests on different sites in the RAAN, native and exotic species that develop well on poor soil can be identified. The following partial list contains examples of species that have a good possibility for development in the climatic conditions and soils of the region.

- **Marañon** Anacardium occidentale
- **Mango** Mangifera indica
- **Guayaba** Psidium guajavo
- **Nancite** Byrsonima crassifolia
- **Acacia** Acacia auriculiforme
- **Mangium** Acacia mangium
- **Melina** Gmelina arboria

The use of such species for green fuel breaks not only offers opportunity for mitigating the effects of fire in the RAAN, but also provides a potential source of products for the use of its residents. This may be an opportunity to integrate productive agroforestry techniques with the more traditional forest protection methods.

LA TRANSFERENCIA DE TECNOLOGIA FORESTAL EN LAS ZONAS TEMPLADAS-FRIAS DE MEXICO

F. Xavier Musalem and J. Manuel Cassian[1]

INTRODUCCION

La investigación forestal se considera relativamente nueva en México. Su formalización se dió hace solo 30 años, con la creación del Instituto Nacional de Investigaciones Forestales, determinación que se incluyó en la ley forestal aprobada en esa época.

Sin embargo, es indudable, que en aquel entonces la investigación forestal ya existía, aunque sin duda, carecía del rigor del método científico que ahora exige. Así, las áreas de operación existentes en las diferentes condiciones de ecosistemas forestales del país, ya implantaban experimentos, como una forma de dar respuesta a sus inquietudes personales.

La investigación durante este período ha estado y continua proporcionando información sobre el manejo de los ecosistemas naturales y sobre el establecimiento de las plantaciones con diferentes finalidades, ádemas lo ha estado haciendo en las distintas fases del aprovechamiento del recurso: abastecimiento, industrialización y comercialización.

Sin embargo, la aplicación de las tecnologías hasta hoy generadas y validadas, no han repercutido en los niveles previstos del mejoramiento, en el cultivo de los ecosistemas naturales, de la producción de los bosques y selvas, ni en la productividad de las diferentes fases de los procesos en los aprovechamientos.

Esta deficiencia, presumiblemente se debe, a la falta de un mecanismo específico, definido y sistematizado que haga llegar con oportunidad y con adecuada asistencia a los usuarios, la tecnología disponible.

Lo anterior no significa, que todos los resultados obtenidos por la investigación forestal se hayan archivado y no hayan podido llegar a los productores o usuarios, sino que las transferencias logradas hasta hoy, han sido parciales y se han efectuado usando mecanismos no ortodoxos.

Bajo estas condiciones y considerando la gran importancia de este proceso en la aplicación de las técnicas forestales obtenidas, así como los débiles resultados que hasta hoy se han logrado, en esta platica se pretende efectuar un breve análisis, sobre la aplicación de la transferencia bajo las características que existían en otros tiempos , para intentar deducir con esa información, una propuesta de estrategia, que prevea la implantación de los resultados de la investigación en las condiciones existentes, derivadas de los grandes cambios que se estan dando en el país y de la influencia de las tendencias internacionales.

Las bases de las propuestas, se darán después de mencionar algunas características de nuestros bosques de coníferas, el fin al que se les tiene asignados, las condiciones en que se encuentra el proceso de transferencia forestal para cada uno de ellos, sus formas de operación, para así concluír con el planteamiento de la necesidad de la transferencia, la ubicación de los conceptos de la sostenibilidad y la posibilidad de llevar a la práctica en nuestras condiciones, su filosofía.

ANTECEDENTES

Definición: conocemos como transferencia de tecnología forestal, el proceso por medio del cual hacemos que en una fase de la producción, una secuela tecnológica generada o validada, comparativamente mejor a la empleada, se comprenda y se utilice en forma ordinaria, por los usuarios.

Hace poco tiempo, la responsabilidad de esta función aunque se mantuvo en la Secretaría de Agricultura, fué asignada a los Distrítos de Desarrollo Rural, que son unidades dependientes de las Delegaciones de Agricultura en cada uno de los Estados.

El proceso de transferencia se previó desarrollar en los Distrítos, apoyandose en técnicos que asesoran a los productores de las actividades agropecuarias y forestales, siendo el conducto para canalizar las tecnologías consideradas más avanzadas en la región, de las actividades específicas.

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Sin embargo, es sabido que el área agropecuaria, presenta características, que en algunos puntos difiere de la actividad forestal y que debían obligar a hacer variar la estrategia de la implantación de la tecnología.

Así por ejemplo, las actividades agropecuarias cuentan con el pequeño ganadero y el campesino o agricultor, sin embargo, el pequeño silvicultor no existe como tal, debido a la necesidad de grandes extensiones que se requieren para cumplir con un plan de manejo que la autoridad exige.

Los periodos de obtención de cosechas resultan también diferentes, ya que en las plantaciones forestales se requieren ciclos de maduración de 15 a 20 años, como mínimo.

. Sin embargo, la diferencia más significativa se debe, a la necesidad, de que cualquier acción técnica que se pretenda efectuar en un ecosistema natural, debe estar considerada en la ley forestal, y la forma de efectuarla, coincidir con la norma establecida por la institución responsable, esto significa, que para poder emplear en forma masiva una nueva tecnología, se requiere, inicialmente demostrar la necesidad de modificar o cambiar la mencionada norma.

Otra característica especial en la actividad forestal, es la necesidad de un intermediario técnico entre la institución y el productor, que se identifica como director técnico, en sus diferentes modalidades, que elabora la planificación, y la ejecución técnica de los programas.

Lo anterior, significa que si una tecnología no está avalada por la institución normativa, los técnicos responsables, no la aplicarán. Esto explica lo que ha sucedido hasta hoy en el proceso de transferencia forestal que se ha dado: la base fundamental es la propia institución normativa, que promueve el empleo de la tecnología que ella misma genera, adecua y que considera la más apropiada.

Esta última característica impidió el desarrollo de las inquietudes personales de los técnicos de la operación, en cuanto al deseo de investigación, adecuación y aplicación, de alguna tecnología específica. Por otra parte, en la actualidad, está generando por la forma precipitada de la implantación de secuelas no validadas, la incertidumbre en los resultados a obtener

Habría que mencionar que cuando nos referimos a la investigación de los ecosistemas naturales y señalamos las fases del proceso , incluímos dentro de ella, ádemas de los estudios sobre el ecosistema, el abastecimiento, la industria y la comercialización.

Sin embargo, hemos observado que en la implantación de las modificaciones tecnológicas para el aprovechamiento de los bosques,se recurrió al apoyo de la institución normativa, que tiene influencia directa en esta área, no sucede lo mismo para el abastecimiento, industria y comercialización , donde la decisión de la implantación, depende directamente de las gerencias de las empresas. Por ello se considera que la transferencia en estas áreas, requiere de un mecanismo especial,que demuestre los beneficios económicos de las propuestas tecnológicas, para su implantación y uso.

En cuanto a los antecedentes referidos a la tecnología de los aprovechamientos forestales en los bosques de las zonas templadas frías, podemos distinguir algunas etapas:

- Hasta 1971, por norma los volúmenes de corta se calculaban a partir de la formula de interés compuesto y la intervención se efectuaba con el tratamiento de selección, que aceptaba una corta hasta el 35% de las existencias y obligaba a un diámetro mínimo de corta. Los fundamentos de está tecnología se encuentran contenidos en el "método mexicano de ordenación de montes". Hasta esta época no hubo necesidad de un programa de transferencia, dado que esta técnica se especificaba como un requisito para obtener y efectuar un aprovechamiento forestal.

- De 1971-1980 la institución normativa, genera y valida una metodología de manejo de bosque regular conocida como "método de desarrollo silvícola" (mds) que se basa en la división física del bosque, en rodales y subrodales. Estas representan el índice de calidad y el estado de las poblaciones.

La posibilidad, se obtiene a partir de un marqueo visual, que se efectua de acuerdo a las condiciones encontradas a los tratamientos que se requieren, que a su vez se identifican con los de un modelo preconcebido. La regulación de la posibilidad se logra al integrar áreas iguales por tratamiento en cada índice de localidad.

La Subsecretaría Forestal además de mantener la norma sobre bosque irregular, previó una estrategia de transferencia de la tecnología mencionada, que incluyó conferencias, capacitación e implantación de bosques demostrativos en áreas comerciales, que incluían todas las formas de organización para la producción.

En esta época grandes unidades de aprovechamiento se inician en la metodología del bosque regular con el sistema mencionado: Bosques de Chihuahua, en el Estado de Chihuahua, el Salto,en Durango, Atenquique, en Jalisco, Michoacana de Occidente, en Michoacán, así como medianos y pequeños aprovechamientos en los Estados de Chiapas, Hidalgo, Tlaxcala, Veracruz y Puebla.

En la actualidad se usa en todo el país. Tendremos oportunidad de escuchar en este foro la experiencia del Salto, Durango.

- De 1982-1984 la propia Subsecretaría Forestal amplía la estrategia de la transferencia a las zonas áridas y tropicales en donde establece áreas piloto de aprovechamientos. Así surge en las zonas áridas "El Plan Sauceda Operativo", en las selvas "El Plan Piloto Quintana Roo", que se inició y continua siendo apoyado

técnicamente por un grupo Alemán que basa su participación en el convenio de cooperación existente entre ambos paises.

Para los bosques de coníferas, se designa en el Estado de Oaxaca, un área de aprovechamiento del ejido San Pedro el Alto, que sirve de laboratorio, para tratar de mejorar las metodologías del bosque regular, específicamente en lo que se refiere al empleo de técnicas de optimización en la definición de las áreas de corta. (Sistema de conservación y desarrollo silvícola-sicodesi).

En estos trabajos la participación técnica del grupo Finlandes es significativa y se basa en un convenio de cooperación forestal que existe entre los dos países.

Esta metodología esta siendo promovida por la propia Subsecretaría forestal a través de cursos de capacitación y entrega de paquetes de cálculo por computadora, que son aceptados como estudios dasonómicos, mismos que continuan siendo un requisito para la obtención de los permisos de aprovechamiento.

- De 1988 a la fecha. En este lapso se desarrollan dos nuevas metodologías de manejo: La generada por la empresa de Atenquique, Jalisco, que considera el manejo de bosque irregular, con las siguientes características: plantea obtener poblaciones regulares de 2 ha. derivadas de las cortas a matarrasas para así formar un rodal irregular.

Esta metodología fué autorizada oficialmente, se sabe que ha operado durante 2 años conforme al planteamiento teórico con grandes dificultades, que obligó a modificaciones que transformaron su filosofía. En éste caso no se previó una estrategia de transferencia.

El Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP), genera el sistema de "manejo integrado" (simanin), que es un método de monte alto regular con algunas particularidades. Incorpora toda la investigación que se ha generado y validado en el país en un modelo de manejo para los bosques de coníferas. En cada tratamiento establece un modelo matemático que define las intervenciones óptimas.

La regulación se efectua considerando áreas de corta disgregadas, al darle mayor peso económico a la prioridad de intervención, apoyado en la alta densidad de la red caminera del bosque.

Además de la madera prevee la implantación de un tipo de resinación intensiva a utilizar en un período de intervención ubicado antes de la primera corta de regeneración, así mismo considera técnicas de manejo de cuencas para el mejor y mayor aprovechamiento en la captación de agua, propone también áreas de protección específica dentro de los rodales.

Su estrategia de transferencia esta basada en la creación de bosques demostrativos en diferentes áreas de coníferas en producción del país. Se inicia con la creación de patronatos de investigación, integrados por los propietarios o poseedores, con la finalidad de programar la investigación dirigida en el corto plazo, para así buscar incorporar los resultados en el proceso productivo. Traspasando de esta manera, la barrera de la tecnología en el manejo e interviniendo también en las fases de abastecimiento, industrialización y comercialización, que hasta hoy en las empresas, ha sido muy difícil de incorporar.

El primer ejemplo en Tapalpa, Jalisco, tiene dieciocho meses de operación. Se ha previsto en el transcurso del año implantar un área en Veracruz y otra en Oaxaca.

CONDICION ACTUAL

Investigación y Transferencia

Hasta hace pocos años la investigación forestal en los tres ecosistemas principales que se tienen en México, se daba por disciplinas, esto es: se efectuaban investigaciones sobre manejo, silvícultura, abastecimiento. Esta secuencia se ha considerado adecuada en aquellos países que cuentan con suficientes investigadores y recursos económicos, en México, lo anterior dió como resultado investigaciones aisladas, por especies o asociaciones e incompletas si se considera todo el proceso productivo.

La situación anterior y la busqueda de la optimización de esfuerzos y recursos económicos, desemboco, en la modificacion del sistema de planeación de la investigación forestal. Así en 1991 se preconizo y se instauro el empleo del llamado "Sistema Producto", que no es más que, el mecanismo que se emplea para priorizar las investigaciones de las diferentes fases de un proceso que se dá para obtener un producto, en una asociación vegetal o por especie.

Por otra parte el sistema producto mencionado, resulta una respuesta a la obligatoriedad de hacer la investigación más eficiente, instrucción que deriva de las reducciones presupuestales que estan sufriendo las dependencias gubernamentales, del cual las instituciones de investigación no escapan. Un presumible impacto de ésta medida será la separación de la investigación forestal estrategica con resultados a largo plazo y la que podríamos definir como investigación dirigida, que busca logros a corto plazo generalmente para ser utilizadas inmediatamente por organismos de producción.

Lo anterior traéra consigo el planteamiento de un nuevo mecanísmo de distribución de la investigación forestal en el país, que sin duda desembocará en el convencimiento a las empresas de producción de la necesidad de incluír en sus organigramas un área de investigación y desarrollo (que en todas las empresas del mundo se emplea y que en México

no se acostumbra), que efectuaría su investigación príoritaria, dirigida y de corto plazo. Así, la investigación estrategica con resultados a largo plazo podrían ser mantenidas en las instituciones de investigación forestal.

Ecosistemas Forestales y Finalidades Asignadas.

En México el universo de la investigación y por consiguiente de la transferencia se encuentran delimitados por las tres grandes zonas ecológicas derivadas de los climas que se presentan en el país: la templada fría, la tropical y subtropical, y la árida y semiárida.

En las áreas anteriores las investigaciones y transferencias forestales pueden ser encasilladas en dos grandes grupos.

- Las actividades que se efectuan y se inscriben en el manejo de los ecosistemas naturales.

- Las actividades que forman parte de las plantaciones forestales.

Es evidente que bajo este esquema la investigación y transferencia deben efectuarse de acuerdo con la finalidad que al ecosistema forestal se le haya asignado, o al objetivo que se pretenda con las plantaciones.

Así la investigación en el manejo de los ecosistemas naturales puede orientarse para los fines de producción de bienes y servicios, de protección hacia otros recursos, de restauración, para recreación, y para la conservación de los recursos. En cada una de estas finalidades, el tipo de investigación sera distinto y la transferencia le correspondera a otros tipos de usuarios.

Lo mismo sucede en el caso de las plantaciones, estas se pueden realizar para fines de producción, para proteger otros recursos, para restauración, con fines de alineación y mejoramiento ambiental en las ciudades y en general con fines agrosilvopastoríles.

Por el desarrollo de la técnica forestal que hemos tenido por la propia evolución del país, nuestra experiencia en la transferencia de tecnología se ha dado únicamente para la finalidad de producción de bienes en el manejo de ecosistemas naturales.

Estamos concientes y es evidente, que en el mundo, el despertar de la conciencia ecológica-medio-ambientalista, repercutirá en la necesidad del fortalecimiento de las investigaciones forestales y transferencias, diferentes a las de producción, que hasta hoy, aunque habian sido tomadas en cuenta no se le había dado la debida príoridad.

Sostenibilidad en Nuestras Condiciones

¿Como plantear la sostenibilidad bajo este contexto?

Sabemos por un parte, que tradicionalmente la técnica forestal se fundamenta en concéptos ecológicos, que ha pretendido un rendimiento sostenído anual períodico de los bienes que se aprovechan, entonces, el ajuste que se requerirá en las áreas de producción, presumiblemente solo se requerirán acciones complementarias y discriminación de áreas.

Así, en nuestro país, creemos que las modificaciones que se darán en el manejo de los ecosistemas forestales naturales asignados a la producción de bienes, serán de inclusión de algunas prácticas tecnológicas, como són:

La separación de zonas representativas de biodiversidad, se deberán consignar como de conservación y ser excluidas de las áreas de aprovechamiento normal, la misma exclusión deberan sufrir las crestas y las simas de los rodales así como las zonas ripeñas.

Algunas prácticas frecuentemente utilizadas deberan ser suprimidas, como son: la corta sistemátizada de los árboles secos, o evitar en lo posible las "quemas controladas".

Para el caso de las plantaciones con fines de producción, la tendencia parece inminente: generar masas con especies mezcladas, valorizar especies natívas y buscar generar poblaciones semejantes a las que se presentan en los ecosistemas naturales.

CONDICION DESEADA

La Filosofía

Con la información revisada, se hace evidente un programa nacional de transferencia de tecnología, que considere las tres condiciones ecológicas derivadas de los climas templado, árido y tropical e incluya las diferentes finalidades que se le asignan al manejo de ecosistemas naturales así como, al de las plantaciones forestales.

Este programa, para el caso específico de manejo de ecosistemas naturales, plantaciones con fines de producción debe considerar una estrategia específica para la transferencia de todas las fases de la cadena del sistema producto, es decir que no solo incluye al bosque, sino también al sistema de abastecimiento, industrialización y comercialización. Estas últimas requieren el convencimiento de las empresas productoras que solo es posible obtener demostrando la economía de la fase.

El Proyecto.

Intentando cubrir las condiciones anteriores el INIFAP genera un proyecto de transferencia llamado "Bosques Demostrativos" que intenta ubicar en los aprovechamientos comerciales de las tres zonas ecológicas el manejo del ecosistema natural.

Se integra un plan de manejo que considera todos los resultados de las investigaciones existentes y adecua con base en bibliografía aquellas fases que aún no han sido suficientemente estudiadas, pero que requieren ser incorporados.

Se hace participar a las instancias que tienen responsabilidad en los diferentes procesos:

La institución normativa, los agentes operativos (Ucodefos), los responsables de las transferencias distritales (Distritos de Desarrollo), los propietarios y poseedores de los bosques, los industriales y los organismos de investigación.

Se integran los patronatos de investigación que financiarán la generación de programas a corto plazo sobre: abastecimiento, industrialización y comercialización, que hacen participar directamente a los productores en la determinación de las prioridades de investigación.

El primer ejemplo de esta estrategia se efectua en Tapalpa, Jalisco en una empresa de pequeños propietarios de bosque e industrias que ha estado operando durante dos años bajo este esquema.

Así mismo, se han iniciado los trámites para implementar "Bosques Demostrativos" en los Estados de Veracruz, Oaxaca y Campeche. Este último ubicado en selvas bajo aprovechamiento.

UNA EXPERIENCIA

Se había mencionado un ejemplo de transferencia que se dió en los años 1972-73, que significó la sustitución de la metodología de manejo de un bosque irregular a uno de bosque regular, por cierto, el primero que se efectuo en México.

El Ingeniero Juan Manuel Cassian nos ilustrará con algunas diapositivas y comentarios los efectos que esta decisión, basada en el uso de los resultados de la investigación, trajo consigo las condiciones que en la actualidad existen en esta zona.

LA TRANSFERENCIA DE TECNOLOGIA FORESTAL EN ZONAS TROPICALES Y SUBTROPICALES DE MEXICO

Javier Chavelas Polito[1]

Resumen.— En este trabajo se hacen breves comentarios a cerca del uso pasado y presente de las áreas forestales tropicales de México, con énfasis a 2 proyectos de transferencia de tecnología. Uno para zonas con selvas poco perturbadas, en las que se a tratado de aprovechar las especies forestales, en forma racional, encontrandose problemas de tipo económicos, sociales, de mercado asì como ecológico-tecnológico. Otro ejemplo es que el INIFAP desarrolla en áreas destruídas por el sistema tradicional del cultivo del maíz, tratando de aplicar técnicas generadas por la investigación, a través de sistemas agroforestales con productores de bajos recursos.

INTRODUCCION

A nivel mundial existe la preocupación de la conservación del medio ambiente del planeta, sobre todo de las posibles implicaciones que el planeta tierra pueda sufrir en base a modificaciones del clima y lo que todo ello conlleva.

La deterioración del medio ambiente se ha dado por diversas razones: explosión demográfica, que se correlaciona con el aumento en el consumo y consumismo de satisfactores, destrucción de la capa vegetal, etc. Hay sin embargo la idea de que el campesino tropical es destructor por excelencia de sus recursos y que lo hace por fastidiar a los ecologistas que presionan a la opinión mundial, para que aquellos modifiquen sus acciones contra de la selva.

En este caso deberiamos (algún día) analizar los factores de presión que de alguna manera influyen en las comunidades nativas o aislados de la gran civilización, que han convivido de alguna forma con su medio ambiente, pero ese convivio resulta inoperante a medida que aumentan las necesidades exigidas por los centros urbanos. Que exigen màs y de mejor calidad, de los productos tropicales a costa de poner en riesgo la subsistencia, no tan solo de ellos sino de la humanidad misma.

En México como parte de la estrategia de conservaciòn de recursos se han estado haciendo estudios del mejor manejo de los recursos naturales, que tiendan a la sostenibilidad de produción de satisfactores para el hombre sin menos cabo de los recursos. Reconocemos que son modestos, infimos, si se quiere. Pero los que hemos vivido en la selva reconocemos que la investigaciòn que falta por hacer es mucha y los recursos económicos sobre todo y humanos son pocos. Y que tenemos que luchar, a menudo, con leyes, con planes políticos (que fracazan al siguiente día) y que desmoralizan a todos y destruyen nuestros recursos.

Las cosas actualmente tienden a cambiar a nivel mundial, pero lo mejor serìa cambiar ecología para que los paises desarrollados paguen mejor nuestras materias primas y no infieran apoyando planes catastróficos de supuesto desarrollo económico, social.

ANTECEDENTES

Con anterioridad a 1983, los aprovechamientos forestales en la Península de Yucatán han sido de tipo extractivo, con escaso orden y poca voluntad de realizar un manejo adecuado a las condiciones de la selva tropical.

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En la historia reciente (50 años antes), el estado de Quintana Roo se colonizò parcialmente, sobre todo en el sur y centro; las dotaciones de los primero ejidos tomando como referencia la principal actividad, la extracción del chicle del árbol de chicozapote, tenían como características;

1) Grandes dotaciones de tierra "per capita", hasta 400 hectáreas.

2) El tipo de actividad llevada a cabo por los ejidatarios favorecía a la conservación de la selva.

3) Se formaron cooperativas con éxito, sobre todo los de tipo chiclero.

En esa época la extracción de maderas sobre todo las preciosas, por la falta de caminos se hacía escasamente y sin control. La extracción se hacia por el río Hondo, lagunas y esteros o en caminos semipermanentes con carretas tiradas por bueyes o tractores.

En 1954, las selvas del sur de Quintana Roo fueron concesionadas por 29 años a una empresa denominada Maderas Industrializadas de Q. Roo (MICRO). Durante esos 29 años la empresa se dedicó a explotar las especies preciosas de caoba, cedro y algo de corrientes. El área concesionada (500 mil ha) a la empresa se ubicaba la mayor parte en terrenos nacionales y algunas ejidales. Coexistiendo la explotación chiclera, a través de cooperativas. La participación campesina era escasa como jornaleros en algunas labores, y como rentistas, en este caso sólo recibían de la empresa exiguas cantidades por el derecho de monte. De igual modo hacían otros concesionarios en menor superficie.

Al transcurrir los años, la población venida se fue asentando formando otros ejidos que cubrían terrenos concesionados a la MIQRO.

Los resultados se fueron agravando en conflictos de índole diversa; por el lado campesino, afectados económicamente recibían dádivas de la empresa y por el otro lado los aspectos tècnicos,había una explotación caótica y desordenada por la colonización campesina y la empresa urgida hizo a un lado los planteamientos originales de aprovechamiento.

Bajo este esquema los ejidatarios y los programas implementados (70's y 80's) del gobierno federal; patrocinados, de algún modo por la banca internacional (Banco Intermericano de Desarrollo, Banco Mundial, etc), y los recursos propios del país, fomentaron más la colonización de campesinos provenientes del interior del país con amplios planes para la mecanización de tierras con fines agropecuarios, entre 1974-1982 se desmontaron con maquinaria unas 50 mil ha en el estado, que por cierto, actualmente están abandonadas.

Al sobrevenir la colonización, en muchas áreas concesionadas a la MIQRO, las selvas desaparecieron por desmontes mecanizados o agricultura tradicional, provocando la quema de grandes áreas subyacentes.

Como antecedentes podemos decir que a finales de los años 70's se aprovechavan maderas preciosas en superficies quemadas, con volumenes superiores a las no quemadas.

Bajo este contexto parecía que la selva era un estorbo para las actividades agropecuarias de los campesinos, a menudo, empujados por presiones oficiales.

La empresa MIQRO no permitía los demontes en sus áreas concesionadas, pero había métodos campesinos para acabar con la selva, su quema simulada, para después aprovechar las maderas muertas de caoba o cedro y el cambio del suelo sobrevenía por consiguiente. El "boom" petrolero de los años 78-82 ayudó a patrocinar planes del cambio de uso del suelo.

PRINCIPALES TIPOS DE VEGETACION TROPICAL Y SUBTROPICAL DE MEXICO

En México existían (actualmente sólo algunos relictos) diversos tipos de vegetación. Miranda y Hernández, (1963) señalan 32 tipos para el país, en los tres ambientes: árido, templado y tropical cálido-húmedo.

En México, su vegetación es diversa y obedece a la combinación de factores físicos como geográficos, geológicos, climáticos, suelos; y a los biológicos, fitogeográficos, paleobotánicos, etc., que se calcula existan unas 40 mil especies vegetales.

En el Cuadro 1 se señalan los 12 principales tipos de vegetación y cada uno puede formar diversas asociaciones vegetales de acuerdo a lo mencionado anteriormente.

Los tipos de vegetación del país han sido descrito por diversos autores como Miranda y Hernández op cit.,Pennington y Sarukhán 1968.; Rzedowski, 1979 y otros.

Del mencionado Cuadro 1 se observa que el 32% de la superficie del país lo cubren las áreas tropicales (México tiene casi 2 millones de km2). La selva baja caducifolia ocupa el 19% localizada en su mayoría hacia la transición con zonas áridas o templado secas. La siguen selvas medianas con 6.1 % y las selvas altas perennifolias con 3.8 %.Otros tipos con menor extensión territorial, como son los manglares, encinares, pinares, sabanas, etc.

Entre 1960 y 1980 principalmente, el desarollo a impactado fuertemente la selva, destruyendo grandes áreas que en la actualidad es difícil reconocer lo que allí existía, quedando sólo reservas forestales en la confluencia de los estados de Oaxaca, Chiapas y Veracruz; Sureste de Campeche y el estado de Quintana Roo, en este estado se han definido, según el inventario realizado, por la Secretarìa de Agricultura y Recursos Hidráulicos (SARH) en 1992, tal como se muestra en el Cuadro 2.

Cuadro 1. — Tipos de vegetación tropical de México (Types of tropical vegetation in México).

TIPOS DE VEGETACION	% DE INDIV QUE PIERDEN SUS HOJAS (*)	ALTURA HEIGHT (m)	LLUVIA (RAIN FALL) (mm)	TEMPERATURA °C	ALTITUD (msnm)	AREA KM2	AREA % (**)
Selva Alta Perennifolia (Rain Forest)	0-25	30 o más	2000-4000	22-26	0-1000	74,562	3.8
Selva Mediana Subperennifolia (Evergreen Seasonal Forest)	25-50	15-30	1200-2600	22-26	0-600	86,988	4.4
Selva Mediana Subcaducifolia (Semi-evergreen Seasonal Forest)	50-75	15-30	1000-1500	20-25	0-600	33,533	1.7
Selva Baja Caducifolia (Deciduos Seasonal Forest)	75-100	15	800-1200	20	0-2000	376,756	19.1
Selva Mediana o Baja Caducifolia (Montane Rain Forest)	0-25	30	1500	18	1000-2500		
Bosque Caducifolio (Montane Forest)	75-100	25	1000-2200	18	600-1800	17,161	0.9
Encinares (Oak Forest)		25	1500-2000	24	0-600		
Pinar (Pine Forest)		10-20	600-1200	24	150 o más		
Palmares (Palms Forest)			800-200	22	0-300	12,427	0.6
Sabanas (Savanna)		5-10	800-2000	20	0-500	19,725	1.0
Manglar (Mangrove)		5-15		22	0-20	14,202	0.7
Acuáticas (Swamp Vegetation)							
TOTAL						635,354	32.0

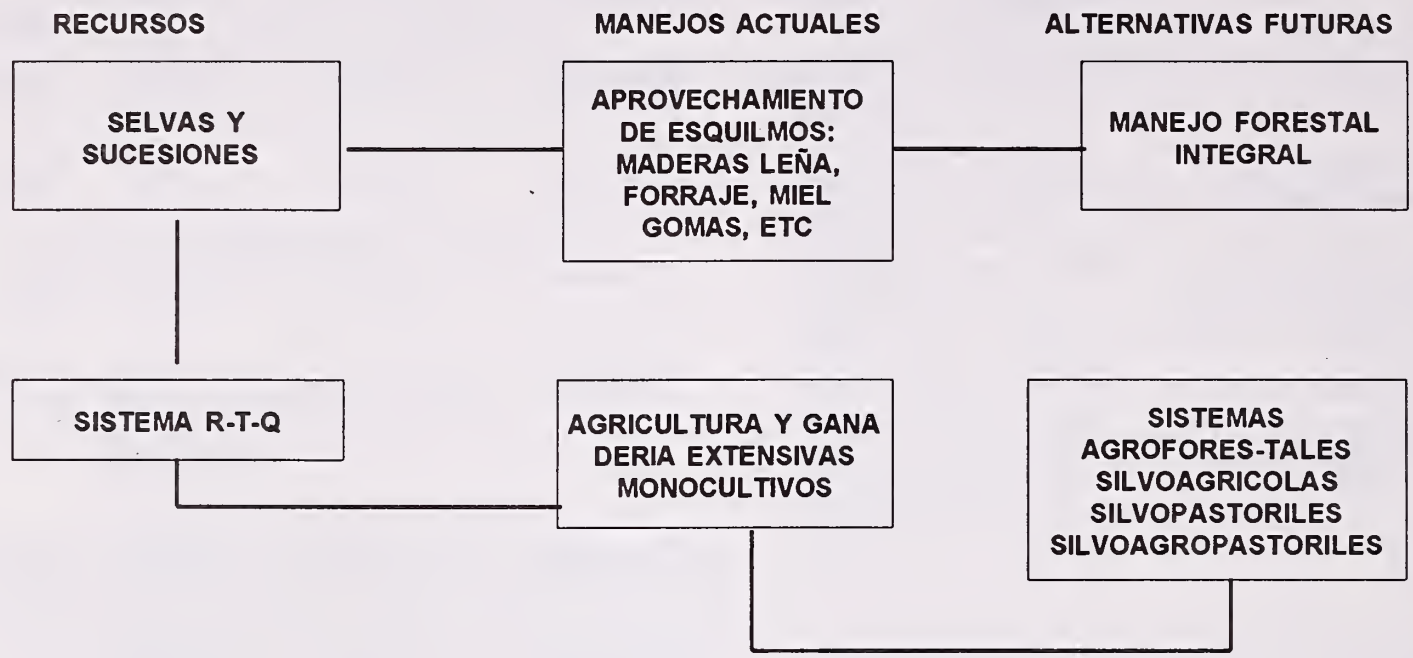
(*) % trees that lose their leaves
(**) % the country area

Cuadro 2. — Superficies por uso del suelo en el estado de Quintana Roo.

TIPO DE VEGETACION	SUPERFICIE (Ha)
TOTAL DEL ESTADO	5,084,300
Superficie Forestal 60%	3,502,766
Selvas Altas Medianas	1,570,620
Selvas Bajas Perennifolias	499,080
Selvas Bajas Caducifolias	1,104,825
Manglares	89,200
Forestal No Arbolada	239,041
Otros usos.	1,581,534
Agricultura Rotatoria (RTQ)	600,000
Vegetación Costera	35,534
Bajos Inundables	384,000
Otros (Lagunas, áreas urbanas, caminos, agricultura permanente, etc.)	562,000

Es de señalar, que es importante la agricultura rotatoria en la Península de Yucatán, por la superficie en que se desarrolla, se calcula que anualmente se desmontan unas 350,000 ha, correspondiendo 200 mil ha a Yucatán, 600 mil ha a Campeche y 50 mil ha a Quintana Roo. Por consiguiente en el Cuadro 2 aparecen 600 mil ha, lo cual se explica por la periodicidad con que se desarrolla el sistema itinerante tradicional de la milpa.

Cuadro 3. — Uso actual y alternativas de sostenibilidad



TRANSFERENCIA DE TECNOLOGIA (2 EJEMPLOS)

MANEJO FORESTAL DE LA SELVA (PLAN PILOTO FORESTAL)

Al finalizar la concesión de la empresa MIQRO en 1983, se encontró una magnífica coyuntura política del Gobierno del Estado y Federal, para que se pudiera cambiar el esquema de organización del aprovechamiento forestal, en la cual los posedores del recurso forestal fueran, hasta cierto punto los actores.

Así nació en ese año el Plan Piloto Forestal de Quintana Roo, creado por ambos gobiernos.

Los planteamientos originales del Plan fueron:

1) Que la conservación de las selvas sólo podrá ser factible en la medida en que su aprovechamiento represente un atractivo económico para el o los dueños del recurso.

2) Que los mismos dueños sean quienes participen de algun modo en las principales labores que el aprovechamiento forestal implique, de tal modo que los jornales económicos generados, queden dentro de la comunidad. Esto representó serios obstáculos, pues muchos querían participar, que sería prólijo comentar, pero que desembocó en cursos de capacitación, en diversos aspectos ejemplo: cubicación, inventario, manejo de documentación (requerida por las autoridades), etc.

3) Que los aprovechamientos deberían ser no solo viables y económicamente atrativos sino que también deberían apegarse a las necesidades de la práctica silvícola para un manejo sostenible.

4) Que la sostenibilidad no se daría si solamente se seguían aprovechando las especies preciosas que la industria más usaba; el término usado para otras especies como "corrientes tropicales" hacía que se usara muy peyorativo.

En general, a vuelta de 10 años se puede decir que el Plan Piloto Forestal ha sido un éxito económico, ha permitido el primer objetivo, sobre todo cubrir las necesidades de los ejidatarios por jornales en los trabajos y en las utilidades generadas.

También se cumple el de tipo social, ya que al trabajar en su comunidad, puede impedir la salida de mano de obra a centros urbanos.

Al principio se trató de obligar a algunas industrias sobre todo a la MIQRO (que ahora solo compraba la materia prima), aunque había otras; a adquirir por cada m3 de caoba obligadamente otros 4 de corrientes; algunos la pagaban pero no la sacaban del monte argumentando incosteabilidad.

Actualemente algunos ejidos poseen, al capitalizarce, a parte de maquinaría de extracción y transporte; aserraderos en donde se asierra casi exclusivamente las maderas

preciosas. Lo que implica en cierto modo volver a la práctica de los sistemas usados por consesionarios, antes del Plan Piloto.

Digo en cierto modo, porque hay aspectos que surgieron sobre la marcha y que a la larga son positivos, por ejemplo: lograr lo que se llama Area Forestal Permanente, en la que el ejido determina un área que sólo será usada con propósitos de una silvicultura racional o sostenible, la cual posteriormente se pacta, con el gobierno estatal como testigo. De este modo en la actualidad los ejidos han asignado alrededor de 538 mil ha de lo que ahora se llama Reserva Forestal Estratégica. Cada superficie forestal permanente, como parte del manejo se subdivide en 25 secciones, para aprovechar una cada año, haciendo un ciclo de rotación de 25 años.

El Plan Piloto Forestal también ha contribuído a la formaciòn de sociedades u organizaciones civiles, para aprovechamiento forestal sobre todo. Con una direcciòn técnica forestal cada una llamadas: Unidades de Conservación y Desarrollo Forestal (UCODEFO), actualmente son 5 en el estado, Estas unidades agrupan 64 ejidos, comprendiendo una superficie total de 1.3 millones de ha.

En conjunto produjeron en 1992-93, 10,498 m3 rollo de preciosas y 9,233 de "otras" especies.

Desde el inicio del PPF (1983) el Instituto Nacional de Investigaciones Forestales (INIF) participó en la implementaciòn del mismo con el apoyo de 3 profesionales, vehículos y equipo. Desafortunadamente, por la fusión de 3 Institutos para conformar lo que es hoy el INIFAP, en 1985 se solicitó se reintegraran los profesionaes adscritos al INIFAP, lo que provocó, distensiones tanto políticas como económicas con el Plan, aunado a la crisis por la que ha atravesado el país, no ha permitido que el INIFAP pueda continuar apoyando lo que debía ser la esencia del Manejo Forestal. Aunque el PPF continúa, ha modificado algunos conceptos originales.

Si observamos el panorama tecnológico que existía y existe al inicio del PPF, veremos la causalidad o deficiencias para la aplicaciòn del Manejo Integral de la Selva:

1a) La información aplicable de la investigación forestal que había era escasa y sobre todo estaba dirigida para plantaciones de especies de rápido crecimiento.

2a) Escaso número de técnicos profesionales con conocimientos adecuados al trópico.

3a) La información sobre tecnología de las maderas de especies tropicales es escasa y dispersa.

Además, hay otros aspectos que han impedido la aplicación del manejo forestal sostenible de la selva (no de la caoba), como ha sido la falta de mercado para las "otras" especies.

La biodiversidad parece un estorbo cuando se desconocen las especies, interacciones, autoecología, tecnología para usos y destinos.

En general, se puede decir que la transferencia de tecnología, para manejo integral de la selva se observa aún lejano. Faltan mucha investigación que después recomendaremos

SISTEMAS AGROFORESTALES

Se practica en las llamadas áreas degradas por haber sido usados y abandonadas bajo el ya citado sistema de roza-tumba-quema, agricultura itinerante, etc. Aquí, el INIFAP considera que pueden aplicarse algunas tecnologías generadas por el propio Instituto mediante sistemas agroforestales.

Cuadro 4. — Clasificación de los sistemas agroforestales.

SILVOAGRICOLAS	AGROSILVOPASTORILES	SILVOPASTORILES
1. Agrosilvicultura (Taungya)	1. Módulos de uso múltiple	1. Pastoreo en plantaciones
2. Arboles de valor en cultivos	2. Arboles asociados a cultivos y ganadería	2. Esquilmo forestal como forraje
3. Arboles en sombra	3. Huerto familiar	3. Arboles de valor en pastizales
4. Arbole frutales en cultivos	4. Polinizadores	4. Arboles mejoradores del suelo por fijación de nitrógeno y estructura
5. Arboles mejoradores del suelo	5. Reservorios genéticos	5. Arboles productores de sombra, pastizales y/o mejoraradores del suelo
6. Cercos vivos	6. Tecnología tradicional	6. Arboles productores de forraje
7. Cortinas rompevientos	7. Manejo de cuencas en pastizales	7. Arboles frutales
8. Arboles en bordos	8. Abonos orgánicos	8. Cercos vivos
9. Arboles y arbustos como soporte	9. Nuevos cultivos no tradicionales	9. Cortinas rompevientos
10. Leñas		10. Manejo de fauna en semicautiverio.

Conviene definir lo que debemos entender por sistemas agroforestales o agrosilvicultura. La FAO (Villarreal y Chavelas, 1986) lo define como: "es un sistema de manejo sostenido de la tierra, que incrementa el rendimiento de ésta, combina la producción de cultivos y plantas forestales y/o animales, simultánea o consecutiva en la misma unidad de terreno y aplica prácticas de manejo que son compatibles con las prácticas culturales de la poblaicón local" en tiempo y espacio.

A) Clasificación de los sistemas agroforestales

Aunque hay varios intentos a nivel mundial, de uniformizar criterios, de acuerdo a Combe y Budowski (1979); Nair (1985) y Villarreal y Chavelas (1986) se hizo el Cuadro 4, que combina fundamentalmente extructura y uso que debe verse en tiempo y espacio.

B) Ventajas de los sistemas agroforestales.

Biologicas 1) Copiar o imitar la naturaleza. Estos sistemas deben copiar a la naturaleza en cuanto a los diversas características de un ecosistema natural como pueden ser.

a) Estratificación horizontal
b) Estratificación vertical (Cuadro 5)
c) Diversidad de especies
d) Estructura y diversidad de formas biológicas
e) Diversidad fenológica
f) Reciclaje de nutrientes
g) Cadenas tróficas
h) Regeneración
i) Sucesión secundaria

Como ejemplo de estas características se dan en los huertos familiares, de traspatio o solares, y en otros cultivares.

Cuadro 5.—Resumen por estratos de un sitio de investigación ecológico-forestal cubierto por selva mediana subperennifolia en el ejido "Divorciados", Q. Roo.

ESTRATO		ESP	IND	ALTURAS MED (m)	COBERT (m2)	AREA BASAL (m2/ha)
ALTO	15.0 O MAS	3	14	17.5	431	1.5212
MEDIO ALTO	12.5	6	70	13.5	1959	6.5992
MEDIO	10.0	9	117	11.1	1519	2.5523
MEDIO BAJO	7.5	23	437	8.4	3467	3.3799
BAJO MEDIO	5.0	10	544	6.4	3554	1.4227
BAJO	4.9	4	76	4.0	443	0.2351
TOTAL		55	1258	10.2	11173	15.7104

2) Suavizan el ambiente al disminuír la evaporación y evapotranspiración, evitando la elevación de la temperatura ambiental.

3) Evitar procesos erosivos del viento o agua.

4) Evitar daños por aires fuertes

5) Fertilización biológica por biomasa y especies fijadoras de nitrógeno.

6) Mejorar la estructura del suelo.

7) Favorecer el reciclado de nutrientes

8) Evitar la posibilidad de la agresividad de plagas y enfermedades.

9) Pueden procurar el reordemiento del uso de la tierra.

Econommico-Sociales.- La práctica de la agrosilvicultura se reconoce que alienta factores que se han ido perdiendo u olvidando por ejemplo:

1) Obtener una gama de productos para autoconsumo o venta.

2) La diversidad y la estructura de agrosistema es menos riesgoso que el monocultivo, por estar sujeto al escaso uso de agroquímicos, mercado seguro y no estar sujeto a variaciones extremas ambientales o sean pocos impactantes.

3) El cultivo de árboles forestales, favorece la alcancia familiar.

4) La división del trabajo favorece la integración familiar y evita la salida mano de obra extra-finca.

5) Hay una reevaluación de las actividades tradicionales campesinas y se le agregan tecnologías modernas que no provocan choque tecnológico.

Parcelas con productores.- Se puede decir que durante los últimos 20 años, el INIFAP y otras instituciones, han generado diversas tecnologías para incrementar de algún modo la producción y la productividad agropecuaria y forestal. En algunos casos esa tecnología se generó para áreas manejados por el sistema RTQ, que por la magnitud de la superficie, se han degradado fuertemente y tienen pocas posibilidades de recuperación.

De este modo en 1989 inicia un proyecto soportado económicamente por un lado por el INIFAP y por el otro el Centro Internacional de Investigaciones y Desarrollo (CIID) de Canada; denominado Sistemas Modulares de Producciòn Agropecuaria y Forestal para la Península de Yucatán.

El proyecto contempla 7 módulos y tiene como objetivos:

1) Mejorar el nivel tecnológico de los sistemas de producción (SP) más representativos.

2) Incrementar la producción y productividad de los Sistemas de Producción.

3) Mejorar el nivel económico de la familia campesina.

En el Estado de Quintana Roo se ubicó, uno de los 7 módulos. Al que se le denominó "Módulo de Producción diversificada en el estado de Quintana Roo".

Dentro del aspecto metodológico se siguieron los pasos siguientes:

Busqueda de un ejido, cercano a los Campos Experimentales del INIFAP. Por economía de los fondos, para que no se dispersara y fuera más accesible el lugar a los profesionales participantes.

Una vez elegido el Ejido, platicar con las autoridades del mismo para ponerlos en antecedentes y emitir su opinión hacia el proyecto.

Después se debe realizar una tipificación de productores en base a sus niveles de inversión en la finca, parcela o casa dentro del ejido.

Elegir uno de ellos con capacidad y proclive a aceptar las innovaciones, padre de familia para ocupar la mano de obra familiar.

RESULTADOS

De este modo se localizó el poblado de Reforma enclavado a 25 km del poblado de Bacalar al sur del estado de Quintana Roo, está conformado por 163 ejidatarios; en su mayoría dedicados a la agricultura de subsistencia, incluye el manejo de huertos familiares o de traspatio. Los cítricos, aves, cerdos y perros son los elementos que predominan. La actividad forestal se limita principalmente al aprovechamiento de cedro rojo, (madera) y el ramón (forraje), así como la obtención de las selvas aledañas de leña, carbòn, hojas de palma y palos para construcciòn rural. En alguna época (unos 15 años atrás), el ejido producia buenas cantidades de maderas preciosas y chicle. Actividad que acabó.

En el ejido también se han hecho atractivos programas para el cultivo de arroz, en las partes bajas inundables de unas 500 ha, pero fracasaron debido a años deficientes en lluvias o por caer en créditos impagables con la banca oficial.

El ejido tiene características muy similares a la de comunidades aledañas, tanto en su entorno ecológico, étnico e histórico.

También predominan productores con bajos niveles de inversión de menos de N$ 15 mil (unos 5000 US DOLLAR), de Éste modo, se seleccionó un productor cooperante de este nivel, llamado Pascual Balam Nic, de 33 años, casado, con 7 hijos (ahora 8).

El matrimonio es de ascendencía maya del vecino estado de Yucatán. Pascual, que se dedicaba a su parcela y en temporadas libres al oficio de albañil (obrero en construcción) en poblados como Bacalar, a donde se trasladaba cada semana.

Se definió la estratégia de mejorar en base a cambios tecnológicos mínimos,y progresivos en el cultivo de la milpa y en el huerto familiar. Y así, acomodar otras actividades productivas como borregos, apicultura, aves para producción de huevo.

Todo esto no se realizó en forma inmediata o conjunta, dado que había que ir observando el desarrollo semana a samana; sobre todo en lo que se refiere a mano de obra, avance y aceptación de las innovaciones.

En la milpa se incluyeron variedades nuevas (Selecciones del INIFAP) de maíz, especies intercaladas y uso de frijol como cultivo de relevo. Los resultados han sido satisfactorios, obteniendose en 1990 hasta 2.9 ton/ha con la variedad de maíz Tzucacab (con otras variedades obtenía anteriormente hasta 700 kg/ha). Para 1991 se reportó 992 kg/ha debido al mal temporal. El frijol de relevo (siembra al cosechar el maíz tuvo un rendimiento de 400 kg/ha. Los ibes (especie de frijol) unos 100 kg/ha.

En el componente del huerto familiar se cultivaron diversas hortalizas y se hizo una adecuación a los árboles de cítricos que ya habita. Estos produjeros 13000 frutos en 1990, 8000 en 1991 y 15000 en 1992. Las hortalizas tuvieron que suspenderse por el ataque de virosis (transmitida por un insecto que se ha transformado en una pandemia regional).

El componente pecuario está integrado por la crìas de borregos y aves de corral. El rebaño empezó con 13 cabezas (12 hembras y un macho), actualmente pasan de 35, habiendo consumido algunos. La alimentación es la nativa en los alrededores de la casa y se le ofrecen sales minerales. Se desparasitan cada 4 meses y se vacunan contra septicemia hemorrágica y carbón sintomático.

Las aves para huevo, se adquirieron 50 pollitos de la raza "Plymouth Rock", cuyos resultados fueron escasos y se va a cambiar por razas criollas adaptados al medio.

La apicultura se inició con 14 colmenas y al productor se le a enseñado el manejo, cosecha, cambio de reynas, así como la adopción de técnicas para el manejo de abejas

africanas; actualmente cuenta con 25 colmenas que produjeron 560 y 800 kg de miel por temporada (90-91) y (91-92).

Plantaciones forestales: en 1990 se incluyeron algunos individuos de caoba (Swietenia macrophylla) y negrito (Simarouba glauca), con alturas promedio de 4.23 y 2.34 m en 2 años, respectivamente. Como eran pocos individuos (unos 40 de c/u), a finales de 1991 se incluyó en otra área que el productor había aumentado, con superficie de 2.5 ha. Se establecieron 9 cortinas de 4 hileras de árboles cada una (9 m de ancho y 3 m entre hileras y plantas separadas por 20 m libres para cultivos intercalados. Se sembraron 6 especies de árboles: Caoba (Swietenia macrophylla), cedro (Cedrela odorata), sacchacá (Dendropanax arboresus), negrito (Simarouba glauca), melina (Gmelina arborea) y chucrasia (Chuckrasia tabularis). Se incluyó entre hileras frutales como plátano (Plantain). A un año de plantadas, las especies que más han destacado son melina con individuos de 5.50 m de alto y 10 cm de diámetro; caoba con alturas de 3.75 m de altura y una sobrevivencia superior al 90%. En este Módulo de Producción Diversificada se pueden concluír provisionalmente los siguientes logros:.

1) Los indicadores económicos de antes y después de los cambios, la relación costo beneficio aumenta a medida que pasa el tiempo y se acompaña con un aumento porcentual de los beneficios.

2) Integración familiar se da al distribuírse la mano de obra en el manejo de los diversos subistemas.

3) Evitar la salida de mano de obra como obrero.

4) Al arraigarse en un área, evita la destrucción de áreas, para agricultura itinerante, que cambie de lugar anualmente.

5) A los profesionales que participamos nos ha dádo la oportunidad de transmitir nuestros conocimientos, a la vez nos retroalimenta para diseñar otras opciones u otras investigaciones. Y sobre todo, la de participar espacialistas interdisciplinarios de áreas agrícola, forestal y pecuaria del mismo INIFAP.

CONCLUSIONES Y RECOMENDACIONES

El área de vegetaciòn tropical y subtropical de México cubre, un 32% de su superficie (1,950 000 km2) que en su mayor parte ha sido destruída quedando pocas áreas representativas.

El estado de Quintana Roo, esta situado en la parte màs oriental de México, con una superficie de 5.03 millones de Ha) limitando con aguas del mar Caribe.

Esta lejanía con el centro del país, y a problemas surgidas del impacto de la colonización de los mayas por los españoles, hizó que en épocas postindependientes surgieran actos como la llamada Guerra de Castas (1847), se despoblara la región. Lo que favoreció la conservación de los recursos hasta casí los años 1960s.En que se abrieron amplios planes de colonización y a la vez dotaciones a ejidales.

Con anterioridad (1953) se crea la empresa paraestatal "Maderas Industrializadas de Quintana Roo (MICRO), a la cual se le concesionan unas 500 mil ha en el sur para la explotaciòn de las selvas, sus planes de manejo originales, fueron modificados al ser invadidas esas áreas por la colonización ejidal. Que ocasionó un sinnúmero de problemas. Al ejidatario el derecho de monte pagado por la empresa era bajo y no cubria sus ingentes necesidades, y para librarse de la presión de la empresa que les impedia sus labores agrícolas, recurrieron a la destrucción de las selvas mediante el uso del fuego que se escapaba de las labores agrícolas.

En 1983 se crea el Plan Piloto Forestal de Quintana Roo (PPF), que en esa época se encontró con un gobierno estatal y federal proclives al desarrollo de un novedoso plan, que comprometia a dueños del recurso y gobiernos.

Aquellos a inmiscuirse en el aprovechamiento, hasta su posible industrialización y de los gobiernos federal y estatal a apoyarlos política, económica y sobre todo técnicamente, a través de profesionales forestales.

De este modo el INSTITUTO NACIONAL DE INVESTIGACIONES FORESTALES (Ahora INIFAP) participó con Ingenieros Forestales, vehículos y equipo, coadyubando a la implementación del Plan. Y del cual se hace un análisis soméro de sus resultado y unas indicaciones de la situación problemática que prevalecía y aun prevalece en la región y si el PPF a logrado algunos objetivos es necesario señalar que el Manejo Integral de la Selva, último peldaño de la posible sostenibilidad operativa, esta aun lejano, faltan todavía más investigación sobre todo.

1) Aspectos de interrelaciones de tipo ecológico sobretodo de biología reproductiva, interrelaciones (medio, flora y fauna), son necesarios.

2) Es necesario conocer las características tecnológicas de las especies. Hay una alta diversidad de especies, en el estado de Q. Roo, existen unas 1300 especies de las cuales 400 son árboles y arbustos lo que no ha permitido el aprovechamiento integral de la selva.

Otros ejidos o propiedades de particulares que no tienen selvas con maderas preciosas han estado condenadas a desaparecer, porque para los dueños no tiene valor desde el punto de vista económico. Actualmente las políticas gubernamentales tiende a cambiar, hacia la protección de la selva y a la reconstrucción de ecosistemas degradados en este aspecto toman fuerza la aplicaciòn de los sistemas agroforestales, aunque sea incipiente, en la cual el INIFAP a generado diversas tecnologías que sean aplicables a áreas degradas y marginadas econòmica y social.En 1989, se inicia un trabajo apoyado económicamente por el Centro Internacional de Investigaciòn y Desarrollo (CIID) Canada, en la cual se conjugan además la voluntad de investigadores agrícolas, forestales y pecuarios, aportando sus experiencias junto con el productor seleccionado. En el estado se estableció un módulo (en la península de Yucatán son 7), denominado "Módulo de Producciòn Diversificada". Después del análisis socioeconómico de los ejidatarios del poblado de Reforma al (sur-centro del estado), se elije a uno por su dinàmica, liderazgo entre los demás , mano de obra familiar (8 hijos). Se han realizado mejoras en su tecnología de cultivo sobre todo de maíz, frijol en la parcela y el huerto de la casa, reordenación de frutales, cultivo de hortalizas, manejo de aves y borregos.

También en la parcela se han incluido la instalación, manejo de abejas para producción de miel; así como cortinas forestales con 6 especies, intercalando dentro de ellos algunas especies aprovechables a corto plazo.En este modelo se han logrado objetivos como el económicoque se acrecienta a medida que pasa tiempo. El cultivar constante un área evita, la destrucción de otras por la agricultura itinerante. La mano de obra familiar se queda y ayuda a la integración de la familia.

Se recomienda este tipo de agrosistemas sobre todo para areas degradadas.

Y para la investigación buscar alternativas de producción bajo agricultura orgánica que sea menos disrruptiva con el medio, asentada en áreas compactas y de manejo perenne.

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TRANSFERENCIA DE TECNOLOGIA FORESTAL EN ZONAS ARIDAS Y SEMIARIDAS DE MEXICO

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Resumen.—Las zonas áridas de México están formadas por el Desierto Chihuahuense, el Sonorense y el de Baja California con una superficie de 1'058,952 km2 lo que representa el 53.8% del área total del país; en estos lugares existe una población cercana a los 15 millones de habitantes. Los sistemas de producción de las zonas áridas fuera de las áreas irrigadas son muy complejas; el productor en pequeño cultiva la tierra, cría ganado doméstico en forma extensiva y es recolector de productos forestales, con mano de obra predominantemente familiar, destinando al mercado los excedentes de producción que le permite su subsistencia. Las zonas áridas de México son coincidentes con una creciente marginación social que tiene como causa principal la sobreexplotación de los recursos naturales; los efectos manifestados por esta sobreutilización ha sido la disminución de la capacidad productiva, explusión de la población rural y dependencia de áreas más desarrolladas; por consiguiente la estrategia de transferencia de tecnología debe de reconocer que ésta debe ser específica para productores de subsistencia, con escasa dotación de terreno, generalmente de calidad y ubicación marginal; con poco o nulo acceso al crédito, a la tecnología moderna y a los servicios de asistencia técnica; que compra sus insumos caros, utiliza sistemas rudimentarios de producción, obtiene bajos rendimientos con altos costos unitarios, vende individualmente sus productos sin agregarle valor y su escaso margen de ganancias solo le permite la subsistencia sin posibilidades de inversión. En esta ponencia se define el perfil del productor en pequeño de zonas áridas, se analiza las contradicciones entre la tecnología generada y las demandas de la agricultura de subsistencia, se señalan las insuficiencias y se proponen algunas orientaciones para generar y transferir tecnologías que permitan la sostenibilidad de las zonas áridas y mejoren el nivel de vida de los productores rurales de estas zonas.

INTRODUCCION

Las zonas áridas de México están formadas por el Desierto Chihuahuense, el Sonorense y el de la Baja California; con una superficie total superior a un millón de kilómetros cuadrados lo que representa más del 53% del área del país; en estos lugares existe un población cercana a los 15 millones de habitantes con una densidad media de 17 personas por kilómetro cuadrado; la densidad presenta fuertes oscilaciones ya que en algunas regiones existen dos habitantes por kilómetro cuadrado, mientras en otros habitan hasta 90 personas.

El desierto Chihuahuense se ubica en la porción norcentral del país, entre la sierra Madre Oriental, el eje neovolcánico y la Sierra Madre Occidental; ocupa parte de los Estados de chihuahua, Coahuila, Nuevo León, Tamaulipas, San Luis Potosí, Zacatecas, Aguascalientes,

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Jalisco, Hidalgo y México; prolongándose hacia el sur en una estrecha franja que penetra a través de Puebla y llega hasta Oaxaca.

El Desierto Sonorense se localiza entre la Sierra Madre Occidental y la Costa del Mar de cortés, distribuyéndose en la Planicie Costera y en las montañas bajas del Estado de Sonora.

El Desierto de Baja California, desierto costero denominado también desierto de neblinas, se localiza en la mayor parte de la península exceptuando las Sierras de Juárez, San Pedro Martir, La Laguna y la porción sur de su territorio.

Los sistemas de producción en estas regiones fuera de las áreas irrigadas son muy complejas, toda vez que se identifican unidades de producción con sistemas forestales que se ocupan de la producción de leña, carbón, forrajes, madera de servicio y productos no leñosos como gomas, resinas, taninos, aceites esenciales, productos alimentarios y farmacéuticos; unidades de producción con sistemas combinados llamados también agroforestales en éstos se practica la agricultura, la cría de animales y/o la actividad forestal en el mismo terreno, en rotación, simultáneamente o en el mismo espacio. Estas unidades de producción en las zonas áridas de México, tienen la función de optimizar las posibilidades ecológicas y económicas de los distintos componentes para obtener una producción total mayor, más diversificada pero sobre todo más sostenida que la que podría conseguirse con el uso único de la tierra; sin embargo, en la actualidad, las zonas áridas son coincidentes con una creciente marginación social donde se práctica un sistema agroforestal de subsistencia que tiene como causa principal la sobreutilización de los recursos naturales; los efectos manifestados por esta sobreexplotación han sido la disminución de la capacidad productiva, expulsión de la población y dependencia de áreas más desarrolladas; por consiguiente, las estrategias de generación y transferencia de tecnología en las zonas de bajas precipitaciones, debe reconocer la necesidad de reestablecer el equilibrio en la relación población/cultura y la incorporación de sus habitantes en la corriente principal del proceso de desarrollo nacional estableciendo una adecuada relación recurso/desarrollo. Esto significa que la tecnología para que pueda ser transferida, debe generarse y ser específica para productores forestales y agropecuarios de zonas áridas con poca tierra, sin acceso al crédito, que compra sus insumos caros, utiliza sistemas rudimentarios de producción, obtiene bajos rendimientos, con altos costos unitarios, vende individualmente sus productos sin agregarle mayor valor y por tanto, sus ingresos son bajos. Su escaso margen de ganancia solo le permite la subsistencia, sin posibilidades de inversión para prosperar y mejorar sus condiciones de vida. Estos son algunos de los problemas que afligen a los productores tradicionales, que constituyen más del 80% del total de los productores rurales del país (2.946 millones) y aportan el 50% del valor de la producción.

CARACTERIZACION DEL PRODUCTOR DE ZONAS ARIDAS

Se procurará efectuar una breve enumeración de las características que se consideran más sobresalientes y que permitan definir con mayor precisión el perfil del productor en pequeño de las zonas áridas de México, para delinear sobre esta base los contenidos temáticos y las prioridades de generación y transferencia de tecnología que se adapten a su cultiva y a los recursos de que dispone. Para fines de esta ponencia se considera como productor en pequeño aquél que cultiva pequeñas superficies de tierra, cría ganado doméstico en forma extensiva y es recolector de productos forestales con mano de obra predominantemente familiar, destinando al mercado los excedentes de producción que permitan su subsistencia.

Para facilitar el análisis del productor en pequeño en función de sus características más distintivas, se ha procurado agruparlos teniendo en cuenta los factores: tierra, trabajo, capital, tecnología, administración y organización social.

Factor Tierra

Uso Irracional del Recurso: El suelo no se utiliza en función de su capacidad. Existe una tendencia a efectuar un uso extensivo e incluso a desaprovechar superficies considerables; cuando se hace un uso intensivo del suelo no se consideran medidas de conservación correctas y la reposición de nutrientes es inadecuada e insuficiente.

Relieve Desfavorable: La tierra por lo general se encuentra ubicada en lomeríos con pendientes pronunciadas o pedregosas, lo que dificulta la realización de las labores de cultivo, las que deben ser en forma manual o con tracción animal.

Tenencia: El no disponer de títulos de propiedad, dificulta la toma de decisiones del productor en pequeño y limita su respuesta a políticas dirigidas en su beneficio; como: crédito, abastecimiento de insumos, oferta de tecnología y asistencia técnica.

Factor Trabajo

Mano de Obra Familiar: Analizando la fuerza de trabajo del núcleo familiar, se ha comprobado que durante el año existen épocas de desempleo o de menor empleo debido a la estacionalidad de los cultivos o del régimen de lluvias.

Baja Productividad de la Mano de Obra: El trabajo del núcleo familiar no rinde lo suficiente por diferentes causas: 1) problemas de salud y estado nutricional que afectan la capacidad productiva y el rendimiento del productor y 2) incapacidad de administrar la mano de obra

disponible. Ante una oferta mayor a la demanda, esta procura encontrar empleo no especializado y de baja remuneración fuera de la unidad de producción en las épocas críticas.

Factor Capital

Baja Capacidad de Reinversión y Nula Capacidad de Ahorro: Los animales domésticos, hacen la función de ahorro más que de producción; cuando surge la necesidad, se vende al intermediario para aliviar la presión urgente. Los productores tienen una reducida capacidad de reinversión y ahorro al tener que destinar la mayoría de lo producido a la subsistencia y por participar en forma esporádica en el mercado de mano de obra.

Escasa Tecnología que no Demande Inversión: La mayoría de las tecnologías que se han tratado de difundir entre los pequeños productores demandan insumos de alto costo y ante la falta de capital, el productor en pequeño posterga los cambios tecnológicos que requieren inversiones que no pueden afrontar.

Crédito

La baja utilización que el pequeño productor hace del crédito se debe a la falta de información disponible, a inconvenientes con la documentación requerida, a trabas burocráticas y a la falta de garantías que, generalmente exigen las instituciones bancarias; así mismo el crédito resulta muy caro debido a la dispersión de la población y las largas distancias de recorrido.

Pérdidas Postcosecha: Por lo general el productor en pequeño almacena en condiciones muy precarias, lo que va a consumir dejando expuesto el sustento familiar a riesgos y a pérdidas estimadas en más del 20%.

Reducida Capacidad de Negociación: Esta situación se agrava aun más por la falta de dinero, lo que determina la necesidad de vender su producto de manera urgente, así como falta de crédito para tener acceso a instalaciones que facilitan su almacenamiento y conservación.

Factor Tecnología y Administración

Ingreso Total de la Unidad de Producción: Los programas de investigación tradicionales, por lo general tienden hacia la maximización de los rendimientos del cultivo o sistema producto específico, aplicando insumos de alto costo, enfoque que no se adecua al interés del productor en pequeño, quien persigue obtener una producción global de todos los elementos que integran su sistema.

Elementos de Trabajo Rudimentarios: Aun cuando el productor en pequeño conoce las principales labores del campo, tiene un bajo nivel tecnológico y sus elementos de trabajo son rudimentarios y anticuados. Dada la baja demanda por implementos mejorados, el sector industrial no ha desarrollado o lo han hecho muy limitadamente, los elementos de trabajo necesarios no dejándole al productor otra alternativa que el uso de sus tradicionales herramientas manuales y de rústicos mecanismos de tracción animal.

Bajo o Nulo Valor Agregado a sus Producto: La venta de productos primarios sin valor agregado, afecta la economía del productor en pequeño, pues recibe precios bajos por su producción y debe pagar precios altos por los elementos semielaborados o manufacturados que adquiere. La agroindustria es poco común y las asociaciones de productores, raras veces se integran para que a través de algunos procesos simples de transformación, permitan agregar valor a sus productos.

No se Llevan Registros: Tal vez, la baja escolaridad del productor de subsistencia y el escaso interés por registrar las actividades de su unidad de producción, impidan que se lleven registros técnicos-contables sobre las principales actividades productivas. No es común encontrar sistemas simplificados de registros adaptados a su cultura que les demuestre la utilidad de esta labor.

Uso Múltiple de los Recursos: Una estrategia usada por los productores de subsistencia es el uso múltiple de los recursos, donde combina distintas especies en el mismo predio, en forma de cultivos múltiples, intercalads, imbricados asociados o suscesivos en el tiempo y en el espacio, además de crianza de ganado doméstico en explotaciones extensivas y de ganadería de transpatio; así mismo, es común la recolección de productos forestales de donde obtiene ceras, fibras, leña, frutos, etc. Esta estrategia le asegura en primer término, los productos básicos de autoconsumo con los mínimos riesgos y dejar los excedentes variados para el mercado.

Lugares de Producción de Difícil Acceso: La producción agropecuaria y forestal de subsistencia se desarrolla en lugares de difícil acceso, complicando el transporte y comercialización de la producción; y esta situación entraba al mercado de la producción y afecta las posibilidades de obtener precios compensatorios, quedando en manos de intermediarios o acopiador, transportarla, almacenarla y fijar el precio final del producto.

El Flujo de Tecnología es Lento: La transferencia de tecnología hacia los sistemas de producción de los agricultores de subsistencia es lento y parcial; ello, no solo se debe al costo adicional que implica la innovación tecnológica, sino también al incremento en el riesgo que puede significar su adopción. El grado de complejidad, los costos de tecnificación y la afinidad del productor con los métodos tradicionales retardan el proceso de la transferencia de tecnología.

La Tecnología no se Adapta a los Sistemas de Producción de subsistencia: Las recomendaciones técnicas que llegan al productor en pequeño, por lo general no se adaptan a sus sistemas de producción; el problema tecnológico no es de fácil solución mientras no se conoscan y definan los sistemas de producción integrados y se

continúe difundiendo o tratando de transferir tecnología de alta productividad por especie o por sistema producto y en condiciones de monocultivo.

Factor Organización Social

Bajo Nivel de Organización: La imagen que tiene el productor de las organizaciones es pobre, lo que explica su bajo nivel de participación. La deficiente organización de los productores de subsistencia distorsiona o imposibilita la canalización efectiva de sus demandas y es causa del desinterés de los sectores responsables para solucionarlas. La falta de organización dificulta la transferencia de tecnología, las facilidades de crédito, de canales de comercialización, mejores precios, etc.

Con base a lo expuesto, las principales características del productor forestal y agropecuario de las zonas áridas de México pueden sintetizarse en los siguientes puntos.

1. Escasa dotación de terreno, generalmente de calidad y ubicación marginal.

2. Recursos de capital limitado, lo cual agrava por su inaccesibilidad al crédito y consecuentemente a los insumos para la producción.

3. Mano de obra predominantemente familiar, cuya oferta para trabajar fuera de la unidad de producción complementa los ingresos de subsistencia.

4. Práctica el uso múltiple de los recursos asociando los cultivos con la crianza de animales y la recolección de productos forestales para asegurar la subsistencia de su núcleo familiar evitando riesgos.

5. Tiene poco acceso a la tecnología moderna y a los servicios de asistencia técnica.

6. Su bajo nivel de escolaridad le impide utilizar racionalmente los recursos disponibles, utilizar las tecnologías apropiadas y organizarse para solucionar sus problemas en conjunto.

7. Sus procesos productivos rinden poco y los productos son de baja calidad, los costos unitarios son elevados y los precios obtenidos son bajos; como consecuencia sus ganancias no le permiten hacer inversiones para mejorar su productividad y condiciones de vida.

8. Produce básicamente para su subsistencia, ofreciendo al mercado sus excedentes sin incorporar valor al producto, vendiendo en forma individual y consecuentemente a bajos precios.

9. Su rendimiento laboral y su desempeño empresarial, se ve afectado por sus precarias condiciones ambientales, de alimentación, salud y servicios esenciales.

10. Aunque se muestra solidario con su grupo de pertenencia, tiene poca confianza en la organización comunitaria, siendo escasa la cooperación entre ellos para enfrentar unidos sus problemas.

TECNOLOGIA GENERADA Y LAS DEMANDAS DEL PRODUCTOR DE ZONAS ARIDAS

En términos generales se puede afirmar que las tecnologías generadas no se adecúan a las necesidades reales ni a las características del productor de las zonas áridas.

Los principales limitantes que se observan son:

- Las políticas que orientan la generación y preparación de tecnologías fueron influenciadas por un modelo de alta productividad y consumo energético, difícil de incorporar a la realidad de las condiciones en que se debate la producción de subsistencia de zonas áridas.
- Las tecnologías emanadas de este modelo, tienden a la homogeneización de ecosistemas muy diferenciados, provocando el desequilibrio ecológico y el deterioro de los recursos naturales. En otras palabras, en lugar de adaptar las tecnologías a las condiciones naturales y culturales, investigando en el propio medio las posibilidades con sus productores, con los recursos naturales que forman su entorno y con los recursos económicos que éstos disponen, el sistema genera tecnologías para los cuales los productores no están preparados, los suelos no responden y los medios necesarios par aplicarlos no se encuentran.
- La dependencia progresiva de los medios importados a que conducen estos modelos, van distanciando cada vez más el avance de la tecnología del estancamiento a que está sometida la producción de subsistencia.

- No se ha priorizado la generación de innovaciones que apunten hacia el manejo más racional de los recursos existentes y más abundantes y que no impliquen fuertes inversiones ni riesgos de consideración.
- No se ha dado suficiente importancia a las tecnologías de bajo costo, de fácil adopción; es decir que estén al alcance de la mayoría de los productores en pequeño en sus propias circunstancias.
- Las investigaciones tecnológicas no han sido complementadas con investigaciones económicas y sociales, minimizando la importancia de los efectos socioeconómicos que pueden provocar las innovaciones.
- Ante el desconocimiento de los sistemas productivos globales obtenidos por los pequeños productores a través del uso múltiple de los recursos, se ha puesto énfasis en la tecnología por sistema producto, buscando la maximización de los rendimientos y descuidando los ingresos totales de la unidad productiva, objetivo fundamental de la producción de subsistencia.
- Las tecnologías modernas plantean una contradicción sistemática entre la rentabilidad, como objetivo prioritario y la racionalidad de las necesidades básicas del productor en pequeño y de su núcleo familiar.
- No se ha tomado suficientemente en cuenta la problemática de los sistemas de producción marginal de las zonas áridas, para proponer alternativas tecnológicas a las condiciones de adversidad ambiental que las caracteriza.
- No se ha dado prioridad a tecnologías que conduzcan a bajar los costos y a aumentar el valor de la producción con el objeto de generar mayores ingresos.
- No se ha generado tecnología suficiente sobre pérdidas ocasionadas durante la cosecha, o sobre el mejoramiento de sistemas de recolección de productos forestales o sobre el mejoramiento de variedades con mayor rusticidad que se adapten a manejos más artesanales de cosecha; lo mismo puede decirse sobre métodos de secado, almacenamiento y conservación de productos.

Para promover la sostenibilidad del sector rural, es necesario incrementar en forma masiva el uso de nuevas tecnologías y estimular el cambio tendiente a elevar la productividad de la tierra y de la mano de obra; si se pretende lograr este objetivo en un plazo razonable, será necesario entre otras medidas, revisar cuidadosamente el sistema de generación de tecnología e intensficar la creación de innovaciones adaptadas a las condiciones ecológicas, económicas y sociales específicas de la mayoría de los productores tradicionales, los que conforman el sector de subsistencia. Continuar importando y adaptando tecnologías generadas en otros países, con estructuras socio-económicas y productivas totalmente distintas a las de las zonas áridas de México, es un camino equivocado de desarrollo que no puede aplicarse a las condiciones que prevalecen; esta situación se vio estimulada a partir de la década de los 50's por intensos programas de postgrado, estos programas permitieron el perfeccionamiento de un destacado contingente de especialistas en temas referidos a la producción de alto rendimiento, elevado consumo energético y desplazamiento de la mano de obra sin que fuera considerada la situación real del productor de subsistencia. A pesar de ello se estableció una base científica que hoy está vigente.

En síntesis, puede afirmarse que las orientaciones dadas a la generación y transferencia de tecnología para el productor de zonas áridas han postergado las demandas del productor en pequeño al que, o no le llegan las innovaciones o cuando le llegan, éste generalmente no está en condiciones de adoptarlas. Al comparar las características generadas de altos rendimientos y elevado consumo energético con las circunstancias del productor descritas en el capítulo anterior, es fácil darse cuenta de que no existe la debida correlación entre ellas; esta afirmación es suficientemente contundente para demostrar la urgente necesidad de adecuar la generación de tecnologías a los requerimientos y recursos de los productores en pequeño. Para tales efectos, es necesario reorientar los objetivos de la investigación; de modo que sus resultados se adapten a las condiciones socioeconómicas y técnico-productivas del usuario; la generación de tecnología deberá basarse en un conocimiento teórico y práctico de los sistemas de producción propios del productor y de los recursos que este posee en su predio, para que a partir de ellos, se generen las tecnologías que sean una efectiva respuesta a los problemas que éstos afrontan.

No se desea dejar la sensación de que se estaría cuestionando los avances de la generación y transferencia de la tecnología, por lo contrario, se reitera la necesidad de no quedarse atrás en la modernización del sector agropecuario y forestal. Lo que es preocupante es que se postergue la generación y la transferencia de tecnología orientadas al uso más racional de los recursos que tienen una relativa mayor abundancia, como es la potencialidad laboral de las familias campesinas de bajos ingresos y los procesos biológicos naturales que deberían ser preferentemente considerados para dar respuesta a la demanda de los productores de zonas áridas.

Pareciera ser que el problema básico radica en que la investigación debe generar tecnologías que se adapten al hombre y al medio ambiente a que están destinadas y no, como sucede generalmente, esperar que sea el hombre y el medio ambiente los que se adapten a las tecnologías creadas sin considerarlos.

TECNOLOGIA PARA LOS PRODUCTORES DE ZONAS ARIDAS

Plan Indicativo de Generación y Transferencia de Tecnología

Frente a la situación anteriormente descrita, que no tan solo origina un deficiente uso de los recursos naturales y limita la potencialidad latente intelectual y físico laboral de las familias campesinas, sino que además posterga el satisfacer sus necesidades reales y buscarles soluciones, se proponen algunas orientaciones estratégicas para abordarlos.

Adecuar las Innovaciones a las Necesidades Reales, Recursos y Potencialidades de los Productores de Subsistencia.

Para ello debe tomarse en cuenta el nivel educacional del productor de zonas áridas, su seguridad alimentaria y nutricional, sus motivaciones, su aversión al riesgo, su limitado acceso a los insumos y servicios y muy especialmente, los recursos que posee en su unidad de producción. Solo así se podría esperar que los resultados de la generación y transferencia de tecnología contribuyan a aumentar la producción y productividad, a partir del desempeño protagónico del pequeño productor y del uso racional de los recursos disponibles.

Estructurar Tecnología que Tienda a Reducir Costos de Producción y Aumentar los Precios de Venta.

Estudiar las posibles actividades previas a la siembra o plantación o introducción de ganado, durante el proceso productivo y posterior a la cosecha, que puedan incidir en bajar los costos unitarios de producción, en aumentar los precios de venta y consecuentamente en mejorar los ingresos de los productores en pequeño.

Establecer Tecnologías que Tiendan al Uso Intensivo del Suelo A Través del Manejo Racional del Sistema de Producción Integrado y del Mejoramiento Fitogenético de las Especies.

Estas tecnologías podrían considerar algunos aspectos entre otros a los siguientes:

- Las pérdidas que significa el suelo improductivo ocupado por malezas, troncos, bordos, caminos, etc.
- La ocupación permanente que debería de hacerse del suelo con praderas; la incorporación de una serie de alternativas de producción que ocupen el predio en todas sus dimenciones a través de diversas especies pecuarias que ocupan diferentes niveles en combinación con cultivos agrícolas y forestales. De esta manera, se consigue un máximo aprovechamiento de la tierra y del trabajo familiar, se aseguran los alimentos para el autoconsumo y se sortea, con mayores posibilidades de éxito las fluctuaciones del mercado.
- La rotación o la asociación con leguminosas para mejorar la fertilidad así como el mejoramiento del suelo a través del uso y reciclaje de nutrientes y desechos orgánicos.
- La utilización de especies y variedades que siendo más productivas que las de uso común y de mayor valor nutricional, no tengan las exigencias de los cultivares de alto rendimiento; o bien el mejoramiento de variedades rústicas que ofrecen mayor resistencia a las plagas y a contingencias climáticas adversas, así como la adaptación de especies o variedades a condiciones edafológicas desfavorables como salinidad, alcalinidad, texturas demasiado arenosas o arcillosas, etc.

Generar Tecnologías que Tiendan a la Autosuficiencia

En muchos países e incluso en México se han realizado experiencias que demuestran el potencial productivo que se puede obtener de una pequeña unidad de producción sin que requiera altos recursos de capital o de insumos difíciles de conseguir. La base del sistema es la diversificación, donde se integran productos agrícolas con productos pecuarios y forestales, de modo de aprovechar al máximo la tierra y el tiempo disponible en los procesos productivos; el sistema comprende el manejo de agua de escurrimiento para el cultivo de grano, tubérculos, cereales, hortalizas y forrajeras; el contorno de la unidad de producción está íntegramente plantado de árboles frutales y forestales.

Las frutas y hortalizas están destinadas al autoconsumo, algunos productos agrícolas y las forrajeras se suministran a la ganadería de traspatio. Las leguminosas de grano proveen las proteínas junto a la producción pecuaria. Los árboles forestales producen frutos, proveen leña, madera y material de construcción. Este es un buen ejemplo de lo que se puede hacer dentro de un sistema de producción integrado.

Otras alternativas que se enuncian son las siguientes:

- Priorizar alternativas que responden a las necesidades más inmediatas a los productores de subsistencia.

- Dar mayor importancia a la investigación de aquellos problemas que cubren mayores superficies y afectan a un mayor número de productores.
- Dar prioridad a aquellas tecnologías que no requieran gastos adicionales de consideración.
- Generar tecnologías que reduzcan inversiones en equipos e insumos caros y difíciles de adquirir.
- Investigar formas de administración rural tendientes a optimizar el uso de los recursos y mejorar la eficiencia de los sistemas de producción.
- Instaurar líneas de investigación orientadas a conocer el comportamiento del productor de áreas marginales.
- Investigar mecanismos participativos y modelos institucionales alternativos que faciliten la agrupación de los pequeños productores.

Biotecnología una Esperanza de Servicio al Productor de Subsistencia

El éxito técnico y económico de la micropropagación de plantas se basa en la capacidad de multiplicar rápida y masivamente genotipos deseables. El impacto de la biotecnología ha sido considerable para el desarrollo de métodos que permiten captar la expresión de la plasticidad genética de plantas y animales o la inducción artificial de ésta, así como métodos para lograr la erradicación de patógenos y para la conservación de genotipos valiosos.

Ejemplos de lo que podría lograrse en ese sentido es la creación o modificación de cultivares de mayor potencial productivo y valor nutritivo, más resistentes a plagas, enfermedades y a ambientes desfavorables. La biotecnología ha producido plantas de tomate capaces de soportar temperaturas invernales al aire libre, variedades de trigo que pueden regarse con aguas salinas, frijol con niveles de metionina adecuados, plantas de maíz con capacidad de simbiosis con bacterias fijadoras de nitrógeno, especies forestales de crecimiento más acelerado y en general especies forestales silvestres con menores exigencias en fertilidad y resistentes al ataque de las principales plagas.

El desarrollo del agro basado en el uso intensivo de energía y de insumos de alta productividad no ha dado la respuesta requerida por los productores en pequeño de las zonas áridas. El escaso capital con que cuentan, imposibilita que puedan acceder a medios de producción más complejos. Ante esta realidad la biotecnología abre una esperanza concreta para volcar líneas de investigación a favor del sector más marginado de los productores rurales, siempre que se decida la utilización de esta nueva conquista de la humanidad para generar tecnologías apropiadas a situaciones de adversidad ambiental y escasez de capital. De lo contrario se correrá el riesgo de que la biotecnología constituya otro avance de la ciencia que beneficie a la actividad agropecuaria y forestal altamente capitalizada y siga marginándose a la producción de subsistencia.

Formación de Equipos Multidisciplinarios

Inspirados por los modelos de los países desarrollados, los resultados de las investigaciones no se compadecen con la realidad socioeconómica de las pequeñas unidades familiares de subsistencia de las zonas áridas de México, con características fundamentalmente diferentes a las demás regiones agroecológicas del país. Si se quiere revertir esta situación, las instituciones generadoras de tecnología deberán buscar la forma de integrar a sus especialistas de los Campos Experimentales con los profesionales de extensión rural y con los productores. Para ello, deberá establecerse un canal de doble comunicación: uno para que los problemas afloren en busca de solución, el otro para que las tecnologías acumuladas y las innovaciones se encausen fluídamente hacia quienes están destinadas. El inconveniente que presenta esta solución es su alto costo y las dificultades que puedan ocurrir para concretar acuerdos entre profesionales pertenecientes a disciplinas tan diferentes. Su ventaja es indudablemente la riqueza de opiniones diversificada que se sumarían para orientar la investigación.

Una segunda posibilidad, más pragmática por su menor costo y factibilidad operativa, es destinar para cada Campo Experimental ubicado en las zonas áridas a profesionales especializados en la elaboración de diagnósticos aplicados a los sistemas de producción que practican los productores de subsistencia para tener una clara visión de estos procesos, detectar sus limitantes y encontrar alternativas apropiadas para solucionarlas; estos profesionales deberán dominar las técnicas de administración rural, así como las de comunicación y relaciones humanas para interrelacionarse con los diferentes niveles culturales. Este equipo de trabajo tendría como misión hacer el relevamiento de los sistemas por unidad de producción, a partir de la realidad cultural de los productores y de los medios con que cuentan; harían un diagnóstico dinámico del proceso completo de producción, recogiendo las tecnologías que se aplican en relación con los recursos disponibles y determinando las limitantes en orden de importancia que frenan la productividad.

La información que se obtenga de los diagnósticos, debería ser analizada por este equipo, junto con los Investigadores de cada disciplina o producto con especialistas de extensión y con representantes de los productores. De este análisis deberían surgir recomendaciones orientadas hacia las siguientes instancias:

- Investigación especializada al estudio de las limitantes detectadas que atañen a su campo de acción.

- Investigación aplicada a ensayar alternativas válidas para las unidades de producción con los implementos y recursos propios de éstas.
- Hacia las organizacioanes de agricultores para comprometer su participación en la planificación y determinación de prioridades de investigación.
- Hacia los organismos de extensión y desarrollo rural entragándoles líneas de tecnología aplicables a la agricultura de subsistencia, las que puedan emanar de la investigación o de las experiencias novedosas que inventan los agricultores y que puedan describirse al hacer diagnóstico.
- El equipo servirá de nexo entre la investigación y la extensión, divulgando hacia estos servicios los limitantes detectados en los sistemas de producción y los cambios tecnológicos que sería posible introducir, comenzando por lo más simple, económico e impactante para la mayoría de los productores y derivando hacia los Investigadores por disciplinas los problemas que detecten en el Campo.

Otra tarea que tendría este grupo es el de evaluar el impacto que la tecnología va provocando en el sistema de producción, midiendo el grado de aceptación de las innovaciones, su adopción en los diferentes tipos de productores, las dificultades que se presenten y la producción real debida a la introducción de dicho cambio.

Por último, cabe mencionar que aunque estas recomendaciones fueron elaboradas para favorecer el grupo mayoritario de productores de subsistencia, muchas de ellas son validas para el sector empresarial, especialmente las que se refieren al mejoramiento genético y al perfeccionamiento de los procesos de producción con ahorro de energía e insumos de alto costo, mediante una eficiente gestión empresarial de sus unidades productivas.

Para muchos, estas orientaciones podrán parecer obvias e inacabadas; tal vez tengan razón, más no se desea sugerir perfeccionismos inalcanzables mientras se den opciones más simples y pragmáticas, pero factibles para las condiciones en que se encuentra la producción agropecuaria y forestal de subsistencia de las zonas áridas, que ha sido la gran olvidada de los programas en pro del desarrollo. Se requiere de soluciones que estén al alcance, que no dependan de recursos externos, que no exijan presupuestos imposibles de asignar y por sobretodo, que sean viables en las condiciones que se debaten los productores de zonas áridas que luchan por su derecho a mejorar sus formas de producción y elevar sus niveles de vida.

> *"El conocimiento es un patrimonio de la humanidad y como tal, debe ser amplia y rápidamente difundido para que beneficie a todas las personas para las cuales ha ha sido generado"*

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A Mexico/U.S. Program for Technical Exchange of Information on Sustaining Migratory Bird Populations

Deborah M. Finch and Robert M. Marshall[1]

Abstract — The Tropical Forestry Program of the USDA Forest Service's (FS) International Forestry branch funded a program for Mexican biologists, resource managers, and natural resource students to participate in Forest Service management and research activities. This program enabled international exchange of information in technologies and philosophies for the conservation of neotropical migratory birds. Eleven Mexican applicants were matched with sponsoring FS National Forests and Research Work Units throughout the United States. The Rocky Mountain Forest and Range Experiment Station arranged travel to and from Mexico and provided information packages, incidental materials, and overhead support for each intern. Interns received training, housing, and a living allowance from each FS sponsor. Sponsors provided project work involving standardized bird count methods, preparation of field forms, habitat survey techniques, and use of field equipment and computers. This program provided the basis for interns to initiate conservation projects, workshops, and training courses in Mexico. Two additional biologists representing Mexico's Secretaría de Desarrollo Social (SEDESOL) were also sponsored to attend a Partners in Flight conference in Colorado in September, 1992. Ultimately, the program's purpose was to strengthen international cooperation in the conservation of neotropical migratory birds.

INTRODUCTION

Neotropical migratory birds, those species that breed in temperate North America and winter in Mexico, the Caribbean, and Central and South America, are a shared, international resource. Over 150 species of landbirds that breed in North America migrate to the tropics during the boreal winter. Western Mexico, in particular, is thought to be the exclusive wintering location for the majority of neotropical migratory species breeding in western North America (Hutto 1992). An estimated 5 to 10 billion birds, or half the total landbird population in North America make this journey bi-annually (Greenberg 1992, Terborgh and Faaborg 1980). However, researchers have documented severe, long-term declines in populations of netoropical migratory bird species as well as changes in the composition of forest bird communities (Briggs and Criswell 1978, Lynch and Whitcomb 1978, Robbins 1979, Ambuel and Temple 1982, Litwin 1986, Robbins et al. 1989, Gauthreaux 1992). Habitat fragmentation on temperate breeding grounds and deforestation on tropical wintering grounds have been implicated as the root causes of the documented declines.

While a strong base of scientific expertise and governmental regulations have stimulated research and monitoring of neotropical migrants in the U.S., fewer projects have been initiated in Mexico. This has created a gap in efforts needed to develop conservation strategies for neotropical migratory landbirds. Noting that more information on the distribution and abundance of neotropical migratory birds is needed in Mexico, members of governmental conservation organizations such as Secretaría de Desarrollo Social (SEDESOL) and Secretaría de Agricultura y Recursos Hidráulicos (SARH) have been actively seeking opportunities to train their biologists. The

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value in sharing research and monitoring expertise with natural resource professionals in Mexico was the impetus for the Rocky Mountain Experiment Station's training program for Mexican biologists. The program was designed to increase opportunities for Mexican resource professionals to acquire additional technical skills necessary to implement research and monitoring programs; to introduce Mexican trainees to sustainable forest management and research concepts and methodologies through the FS volunteer program; to develop opportunities for in-country workshops and training; and to foster greater awareness of the problems natural resource managers on both sides of the border face in developing conservation strategies.

PROGRAM IMPLEMENTATION AND CRITERIA

The U.S. Forest Service (FS) has an established Service-wide Volunteer Program available to citizens of the United States and foreign countries. Volunteers may receive a modest subsistence fee by accumulating "per diem," and, typically, are provided with housing. Depending on experience and interest, volunteers may perform similar duties as paid employees and are given similar training. The Service's Volunteer Program enabled us to offer training to Mexican interns. Staff at the Service's Rocky Mountain Experiment Station arranged travel to and from Mexico, and provided information packages, incidental materials, and overhead support. Interns received training, housing, and per diem from each FS sponsor.

The program was announced in December of 1991 to FS personnel cooperating in the *Partners in Flight - Aves de las Americas* initiative. *Partners in Flight* is a coalition of more than 50 federal agencies, non-profit conservation organizations, and private industry groups (Eno 1992). Potential FS sponsors included Districts or Research Work Units working on neotropical migratory bird research or monitoring projects. Potential sponsors responded to requests for proposals describing the types of projects and training interns would receive. Six criteria were used to evaluate submitted proposals: 1) the extent of focus on neotropical migratory birds; 2) the ornithological experience and skill of the sponsor; 3) quality and diversity of training proposed for the interns; 4) proposed work location; 5) accommodations for interns, and 6) social/cultural atmosphere available to the interns.

With the help of SEDESOL, SARH, and several Mexican conservation organizations and universities, 45 potential interns were identified and encouraged to apply for the program. Successful applicants were selected using four criteria: 1) interns were either a student in a natural resources curriculum at an education institution, or they were an employee or volunteer in a governmental or private organization concerned with natural resource issues; 2) they were interested in neotropical migratory birds and *Partners in Flight*; 3) they were able to remain through the duration of the particular training project, and; 4) they were able to meet the physical demands of the assignment. Interns were matched with FS sponsors based on the types of skills they were interested in obtaining. For some, other factors were also used, such as time constraints, experience operating four-wheel drive vehicles, intern's ornithological experience, and fluency in Spanish/English of both parties.

PROGRAM RESULTS

Enthusiasm within the FS for the *Partners in Flight* initiative and widespread concern over habitat loss in Latin America prompted immediate interest in the program. Proposals from 11 National Forests and 5 Research Work Units were submitted for the 1992 field season. Based on funding, eight male and three female Mexican interns were selected and were matched with 10 sponsors. These interns represented six Mexican states and seven governmental agencies, non-profit conservation organizations, and academic institutions participated in training programs from 1 June to 31 August. Eight interns represented six non-governmental conservation/educational organizations: Biocenosis, Quintana Roo; Laboratorio Natural Las Joyas, Jalisco; PROFAUNA, Chihuahua; PRONATURA, Chiapas and Yucatan; Proyecto Mexico, Veracruz; and Universidad Michoacána de San Nicolas de Hidalgo. Three interns were from INIFAP, the research arm of SARH in Michoacán. Interns were hosted by National Forests (NF), Regional Offices, or Research Work Units in seven states: Arizona (Rocky Mountain Research Station); California (Cleveland NF; Klamath NF; Inyo NF; Pacific Southwest Research Station); Colorado (White River NF); Montana (Regional Office, Northern Region); Michigan (Hiawatha NF); Ohio (Wayne-Hoosier NF); and Oregon (Willamette NF). In addition, two biologists from SEDESOL were sponsored to attend a *Partners in Flight* Conference held in Estes Park, CO during September 1992. This conference, attended by over 700 participants, brought together a wide variety of organizational interests in *Partners in Flight* and offered a strong introduction to the state-of-the-art knowledge on neotropical migratory birds. Copies of the Conference Proceedings, Status and Management of Neotropical Migratory Birds, published by the Rocky Mountain Experiment Station, will be provided to interns.

Interns participated in a wide variety of FS research and monitoring projects pertaining to neotropical migratory bird populations. Some interns received highly specialized training in standardized bird counts, banding methods, habitat survey techniques, and field equipment use. Graciela Mandujano Chavez from Universidad Michoacána de San Nicolas de Hidalgo, for example, studied the distribution and nesting productivity of neotropical migrants breeding in

continuous and fragmented forests of western red cedar/western hemlock in Idaho. Under the direction of Dr. Sallie Hejl and her colleagues, Graciela learned observational census techniques and nest-search protocols. Graciela also spent several weeks mist-netting migratory birds at a MAPS station (Monitoring Avian Productivity and Survivorship) in Montana where she learned how to capture, handle, and band migratory birds, and to differentiate adult and juvenal migrants.

Other interns investigated research or monitoring program objectives. Gilberto Chávez-León, a research wildlife biologist from INIFAP, interned with Dr. Deborah M. Finch at the Rocky Mountain Experiment Station in Flagstaff, AZ. During his stay Gilberto visited a number of biologists and wildlife program managers in the Service's Southwestern Region (Arizona and New Mexico) gaining exposure not only to field investigations, but also to programmatic goals and approaches. As a researcher whose responsibilities encompass the Mexican state of Michoacán, Gilberto learned how the FS coordinates neotropical migrant initiatives at the regional level here in the U.S.

Gilberto, Graciela, and David Gutierrez Carbonell, an intern from BIOCENOSIS in Cancun, Quintana Roo, visited Washington, D.C. where they discussed their FS experiences with FS staff in International Forestry, Research, and National Forest System. They also met with other organizations cooperating in *Partners in Flight* such as the U.S. Fish and Wildlife Service, the Smithsonian Institution, The Nature Conservancy, the International Council for Bird Preservation, the National Audubon Society, and the National Fish and Wildlife Foundation.

While the Mexican interns gained exposure to the wide variety of FS programs for neotropical migratory birds and training in contemporary research techniques, FS sponsors also derived much benefit from the program. Many of the interns already possessed skills that benefitted FS sponsors. Jorge Montejo Diaz, Proyecto Mexico in Veracruz, was an expert in raptor identification and trapping, and provided biologists on the Klamath NF in Oregon with invaluable assistance in their Swainson's Hawk project. Forest Service biologists on the Klamath commented that the most exciting part of Jorge's internship was the potential for future collaboration with Mexico on projects for neotropical raptors. Similarly, David Bacab Ortiz, from PRONATURA in the Yucatan and a tour guide specializing in ecotourism, gave a slide presentation on neotropical migrants and the birds of Mexico to over 100 members of the public while interning at the Hiawatha NF in Michigan. David's discussions on wintering habitats and food sources for neotropical migrants gave Hiawatha biologists "a better understanding of what the birds are doing in the winter and what kinds of problems they face in the Yucatan Peninsula."

Although the foundation of our training program for Mexican biologists lies in the exchange of technical knowledge, one of the most important benefits of the program is the exchange of ideas and greater awareness of how cultural, institutional, and economic priorities in the U.S. and Mexico shape attitudes and, ultimately, conservation policies and practices. In an increasingly populated and technologically advanced world, successful conservation strategies will depend more on fostering cultural attitudes that embrace concepts of biological diversity and ecosystem health than on the mere possession of data and ability to apply techniques. Thus, the development and success of international conservation strategies for migratory birds, or any other taxa that cross international boundaries, clearly rests on the willingness of people to understand and appreciate the attitudes and cultural priorities of others. For those interested in developing similar programs based on technical exchanges, we suggest program developers explore ways to maximize the opportunities for both social and technical/scientific exchanges.

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Southwest Region and Arizona State University's Pro-Active Resource Management

Jon S. Bumstead[1]

Abstract.—The Pro-Active Resource Management graduate class jointly developed and presented by Arizona State University and the Southwestern Region of the Forest Service has been underway for three years. It embodies the concepts of the Forest Service's New Perspectives program to strengthen our ties with Universities and research across the Nation. This class best reflects the Southwestern Region's New Perspectives implementation efforts, regarding University partners to:

1. Capitalize on University knowledge for our project and program planning efforts; and to advise University research scientists about the kinds of technology we need.
2. Search out "non-traditional" University expertise relevant to today's management situations.
3. Advise professors and program chairs about the skills newly graduated professionals will need to be effective in the workplace.
4. Provide a "safe" forum for discussion of emerging or pressing issues amongst professors, students, citizens and agency personnel.

The Pro-Active Resource Management class has contributed significantly to each of the Regional implementation goals listed above.

INTRODUCTION

Three years ago, as Forest Planner on the Santa Fe National Forest, I found myself completely engulfed in formal and informal public appeals to timber sale proposals, mining proposals, powerline proposals, range allotment plans, etc. Nearly every project proposed on that Forest was appealed and/or litigated. This kind of public outcry was, and still is, occurring across the Nation. A significant number of people were looking for a different mix of goods and services from their National Forests and Grasslands. It was a new ball game for most of us. After all, who did the public think they were, telling us how they wanted their lands managed?!

From my perspective many Forest Service personnel weren't prepared to effectively address this massive movement and shift in values. We had always been known as a "can do" organization. However, our schooling hadn't taught us how to effectively interact with a public whose values and ideas of proper forest management had shifted significantly. What they wanted was certainly different from what we had learned in forestry school.

Further, the appellants quickly learned to use our National Environmental Policy Act as a means to stop projects they didn't like (most of them). As I worked through the appeal statements, with my work supervisor, I frequently found myself telling him that the appellant was right on certain allegations. Sometimes we really hadn't done a complete job of analyzing a certain aspect of the proposal. Or, indeed we hadn't utilized the latest scientific techniques in accomplishing our analysis. Having this kind of conversation with your boss on a day to day basis isn't a lot of fun. Sometimes he would decide to go ahead with a

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proposal and risk having to defend a flawed environmental document. Other times we would withdraw the decision and do more analysis. Neither situation made us feel very good.

I started thinking that there must be a better way. From my perspective, the Forest Service had to admit that our credibility and public trust were seriously eroded. We had to try new and different ways to change the situation. Bill Russell, the past director of Land Management Planning in this Region, and I saw an opportunity to begin a long term approach to reshaping our image. We felt this could be accomplished, in part, through development of a closer working relationship with Universities, students, research and interested citizens. The program we developed and launched is described next.

PROGRAM OBJECTIVES

This program had four main objectives which are briefly explained as follows:

1. To strengthen our working relationship with Universities throughout the region in order for the Forest Service to capitalize on the latest scientific technologies available for project and land management planning and to put professors in working situations where they could see how applicable their theoretical models would be in the "real" world.

2. To capitalize on University and research expertise in non-traditional arenas. Communication departments have been used to teach/train our people in various interpersonal skills. Sociology departments can help us learn about public perception regarding our management activities in an unbiased manner. And, as we accomplish these classes and/or training workshops those professors gain an appreciation for the Forest Service and our people just as in item 1.

3. To advise the professors and program chairs on the kind of employee the Forest Service is going to be looking for in the foreseeable future. We are looking for graduates who "like" to be involved with people. The day of the "Forester" going to the woods each day to be alone with nature is gone. We need well rounded individuals who like to work with people.

4. To utilize the University setting as a "safe" environment for open and candid discussions regarding emerging and/or pressing issues.

Most of the seminars, classes or workshops that we have developed are open to any interested citizen, "regular" students and agency personnel. Through careful stage setting methods awareness levels are raised, views are openly expressed and listened to and everyone leaves the setting with a new perspective of the topics under discussion.

The following is a more detailed description of how we are implementing the objectives of the program. The Pro-Active Resource management class is our best overall example. The class has been underway for three years. We hold it each spring. This class was recently recognized at a National Forest Service/University colloquium as a desirous format for technology transfer and University partnerships.

BASIC AGREEMENTS OF ARIZONA STATE UNIVERSITY AND THE SOUTHWESTERN REGION

The Pro-Active Resource Management class started with the premise that we would be open to class content and structure. In addition we developed five other basis class content and structural ideas: 1. Each year the class would address the "hot" topic of the day. 2. The importance of effective communications would be stressed at the beginning of each class. 3. That we would actively seek a wide range of participants and participant viewpoints. 4. That our teaching methodology would take the form of work groups and interactive discussions rather than a lecturing format. 5. That we would actively seek other joint relationships that might emerge as a result of this class. The following paragraphs describe how each of these basic elements have developed and the results which have flowed form them.

IMPLEMENTATION OF BASIC IDEA THEMES

The "Hot" Topic

So far our class themes have included; analysis/decision processes, integration of Geographic Information System (GIS) technology into the analysis process, and examining an ecological approach to rangeland management. Out of these themes an additional cooperative effort has emerged. It will be discussed in item 5, "Emergent Relationships". I think the most important aspect of addressing the "Hot" topic is that is forces the team of professors and agency cadre to themselves carefully "think" their way through the

topic. We've found that often the most important "teaching" is what we teach ourselves in preparation for the classroom exercise.

Effective Communications

Time and time again as Forest Planner of the Santa Fe National Forest and again in the University Liaison position, I have seen ineffective communication as "THE" biggest stumbling block to accomplishing our work. In our Pro-Active Resource Management class we dedicate the first four hours to getting acquainted, working with a professor from the communications department and doing hands on work group exercises. Everyone, including the instructors, participate in these exercises. Later in the session, when we are discussing the "Hot" issue, everyone is far better prepared to listen to divergent views and value the perspective other persons bring to the topic. The time spent on communications in the beginning is probably "the" primary reason that the class is successful.

Participants

One of the broad program goals was to create a "safe" place for people with divergent views to discuss openly and candidly their feelings on important issues. It was our hope that we could all learn more about each others perspectives on various issues in a non-threatening environment. The Pro-Active Resource Management class has worked out exceedingly well in this regard. In addition to graduate students and agency personnel we have had miners, ranchers, senior citizens, city planners, Audobon Society members, teachers, a football coach and citizens from many other walks of life take the class for credit, knowledge and/or just for fun. Once again, this mix of people probably wouldn't work without the communication skills work at the beginning of the session. By the time the professors from the Communication Department get done with the participants everybody is dedicated to active listening.

Many positive spin-offs have occurred from having this broad spectrum of participants in the class. For example, the students get to here all sides of management issues from real people. Many individuals explain their positions with great fervor and depth of conviction. The best professors can't begin to explain in a normal classroom setting the intensity that exists around many of our issues. Another example, my favorite one, is when a city planner, during those course critique, said: "I had no idea of the complexity of the issues the Forest Service is addressing. I had no idea of how involved your planning processes are. Keep up the good work; and keep doing this kind of thing to raise our awareness."

Teaching Methodology

Not many Forest Service personnel are very comfortable presenting lecture material. I suppose that contributed to our designing a class structure that avoids lectures like the plague. More importantly adults like to be actively involved in the learning process. That fact, plus our desire to have open exchanges of opinion, led us to the work group format. Before the first morning of class is over the participants and instructors are actively engaged with small work group activities (5-7 per group). Everything that occurs throughout the three days of class is accomplished through the work group setting. This year each work group made management recommendations to the Tonto Basin Ranger District on how to manage the land around Roosevelt Lake and adjacent riparian zones. The management situations presented were real and the District Ranger is going to seriously consider the input from each work group.

The best thing that has occurred each year is that in mixing students, agency personnel, commodity interest, and non-commodity interests into each work group we get some invaluable exchanges of perspective. We all learn.

Spinoff Projects

As we presented the classes with Arizona State University on Analysis Process, Geographic Information System technology, and an Ecological Approach to Rangeland Management we discovered a need to develop a "Guidebook" for integrating each of the class themes into a useful form. The first recognition occurred about a year and half ago. A group of interested Forest Service personnel and myself started a "Think Tank" to examine how Geographic Information System (GIS) technology could be utilized for analytic purposes within the Regional Integrated Resource Management (IRM) planning process. We accomplished this task, in cooperation with Northern Arizona University, and published the results in a pamphlet called: "A Guidebook for use of Geographic Information Systems in the Integrated Resource Management Process". This booklet is available through the Rocky Mountain Research Station in Fort Collins, Colorado.

We are currently engaged in a much more complex task with Arizona State University and an ecologist from the Rocky Mountain Research Station. This time we are trying to develop a similar guidebook that integrates an ecological approach to rangeland management while utilizing Geographic Information System technology within the National planning process called Forest Plan Implementation (FPI). Three of the professors from the School of Agribusiness and Environmental Resources are active members of this latest "Think Tank" effort. What a learning experience we are all going through in the development of this guidebook. This work is not complete; yet!

SUMMARY

It is a great experience to find a grouping of people who can effectively work together. This has occurred with Professor's Brock, Brady, and Miller from the School of Agribusiness and Environmental Resources and many Forest Service personnel from the Regional Office, Prescott, Tonto and several other National Forests. As a result of this relationship we have all learned new ways to be more effective in our jobs.

I once heard that each person influences a circle of about 250 people. If that is true, then our three classes have potentially affected nearly 25,000 people. I know the effect has been positive because each year the participants have told us so. Most importantly, all participants are exposed to the latest thinking regarding management "tools" and given an increased awareness and understanding of the value each person can bring to the table.

Neotropical Migratory Birds and Forest Sustainability In Mexico

Gilberto Chávez-León and Deborah M. Finch[1]

Abstract — The Neotropical Migratory Bird Conservation Program, also known as Partners in Flight, serves as a model information exchange program for conserving a natural resource shared by Mexico and the United States. Rapid loss of habitats owing to deforestation may jeopardize the survival of migratory and resident birds that use Mexican forests. Sustainable forestry initiatives can help to conserve Mexican forests, sustain bird populations and their habitats, and still provide for economic progress. A younger generation of Mexican citizens has been taught to value the high biological diversity associated with Mexico's tropical rainforests, cloudforests, and temperate forests. To maintain Mexico's diverse wealth of biological resources while continuing to meet public needs and expectations for wood products, we recommend that agencies adopt an ecosystem-based, multiresource approach to managing forests.

INTRODUCTION

Migratory birds are a distinctive biological resource shared by Mexico and the United States. Conservation measures to protect long-distance migrants are difficult to develop because they must cross international borders. Yet, such efforts often lead to opportunities for international cooperation on broader conservation issues. In the case of migratory birds, different countries must coordinate efforts to sustain viable populations of bird species that contribute to global biological diversity. Conflicting positions often arise because different countries have different natural resource priorities, and these are reflected in the legal systems of each country's government.

Recent analyses of local and regional bird population counts, radar migration data, and capture data from banding stations show that forest-dwelling bird species, many of which are neotropical migrants, have experienced population declines in many areas of the United States (Terborgh 1989, Askins 1990, Finch 1991). The factors that have been advanced to explain the population declines include forest fragmentation on the breeding grounds, deforestation of wintering habitats, pesticide poisoning, or the cumulative effects of these factors.

The Neotropical Migratory Bird Conservation Program, better known as Partners in Flight - Aves de las Américas, is a cooperative venture initiated in 1990 by numerous United States agencies and organizations to address the population declines of neotropical (i.e., long-distance) migratory landbirds that breed in North America and overwinter in Latin America and the Caribbean Basin. Partners in Flight agreements, projects, and workshops are now being planned and implemented by organizations in Canada, Latin America, and the Caribbean. The program emphasizes that cooperative research, monitoring, and habitat management actions be implemented simultaneously in breeding and wintering areas, and that conservation activities embrace the goal of sustainable development for human populations (Finch 1991).

In this paper we present an overview of the problems faced by migratory landbirds in Mexico; discuss implications of the Mexican legal system for conservation and management of wildlife and other natural resources; and describe how Partners in Flight can help promote conservation of migratory birds through technology transfer efforts.

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FOREST MANAGEMENT IN MEXICO

Population reductions of neartctic-neotropical migratory birds, i.e., those migratory species that breed in Canada and the United States and winter in Mexico and other Latin and Caribbean countries, contribute to loss of biological diversity throughout the New World. Declines have been attributed to human activities such as forest fragmentation, tropical deforestation, and general habitat loss (Terborgh 1989, Askins et al. 1990, Finch 1991). The majority of winter habitat where most migrants concentrate is found in Mexico, Central America, and the Caribbean Basin (Rappole et al 1983). This same geographical area is also where rates of deforestation in Latin America are highest (Terborgh 1989). In Mexico alone, 25% of the country is covered by forest (49.6 millions of hectares), of which 51.4% are temperate forests (25.5 mil ha), and the remaining 48.6% are tropical forests (24.1 mil ha). Shrublands cover 35.9% of the country's surface (70.3 mil ha), and secondary forests cover 11.0% (21.6 mil ha). The annual rate of forest loss from 1980 to 1990 has been estimated as 0.71% (365,000 ha/year). The same source predicts a deforestation rate of 0.55% (283,000 ha/year) for the decade 1990-2000 (SARH 1992).

Whereas annual deforestation rates of Mexican temperate forests were 0.73%, Mexican tropical forests were cleared at a faster pace, 1.8%, in the same decade 1980-1990. Migrants that breed mainly in the eastern United States and Canada concentrate in southeastern Mexico in areas like the Yucatan Peninsula and Chiapas to winter or stop temporarily on their way to and from Central America (Lynch 1989; Greenberg 1990). Southeastern Mexico is where most of the country's wet tropical forests remain and where deforestation rates are highest. Disappearance of Mexico's tropical rainforests reduces the likelihood that eastern migrants, especially those that use forests to the exclusion of other habitats, can survive over winter.

In contrast to eastern migrants, most western migrants winter in a more restricted area in western Mexico where they use temperate and dry tropical forests (Hutto 1986, 1987). Unlike many tropical forests that are converted to agriculture, temperate forests in Mexico are more likely to be exposed to problems related to direct human use, mistletoe infestation, fires, insect pests, diseases, and weather. Forestry practices that are not designed to sustain temperate forests over the long term may contribute to reduction of habitat suitability for forest-dwelling western migrants.

WILDLIFE CONSERVATION WITHIN THE MEXICAN LEGAL SYSTEM

Wildlife in Mexico has been managed as an individual natural resource under the Federal Game Act (Ley Federal de Caza) of 1952, and by a regulation for the use of songbirds for the pet trade issued annually, with no mandated protection of wildlife habitats. This led to exploitation of Mexican forests which were valued only for their commodity resources. Not until 1988, when the Mexican Environmental Protection Act (MEPA; Ley General del Equilibrio Ecológico y la Protección al Ambiente) was enacted, did Mexico adopt a policy for conserving its natural resources that followed an integrated multiresource approach. However, enforcement of the Mexican Environmental Protection Act has been only partially successful because of economic, legal, and political constraints.

Under the current direction toward conservation within the Mexican government, a new Forestry Act (Ley Forestal) was passed in December 1992. This law emphasizes an integrated approach for the use and conservation of all forest resources. Its goals include the conservation, protection, and restoration of forest resources and the biological diversity of their ecosystems; and sustainable management of commodity and non-commodity resources for the benefit of the people without reducing the capacity of a forest to regenerate itself. These goals are similar to the philosophy of sustainable development as defined by the World Commission on Environment and Development (1987) which is: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

To authorize timber sales the Forestry Act of 1992 mandates a forestry management program that must include, among other requisites, measures to conserve and protect habitats of threatened or endangered wildlife species. The Act also regulates the administration of National Parks and protected areas to ensure the conservation of forest ecosystems. Under this new approach, state governments as well as non-governmental organizations are authorized to take responsibility for the care and management of such protected areas.

Based on the Game Act, the new Forestry Act, and the Environmental Protection Act, two federal agencies now have responsibilities for the regulation, protection, and management of natural resources in Mexico: Secretaría de Agricultura y Recursos Hidráulicos (SARH) and Secretaría de Desarrollo Social (SEDESOL). Although sharing responsibilities for managing natural resources between two mayor agencies may seem complex and inconvenient to coordinate, in fact it might facilitate new conservation initiatives. For instance, wildlife protection and management is the sole responsibility of SARH, while SEDESOL is in charge of regulations and law enforcement. Under this scheme several ongoing activities related to hunting regulations, songbird pet trade regulations, law enforcement, and the establishment of a national wildlife inventory, are coordinated between SEDESOL and SARH, including participation of governmental research agencies such as Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP) and non-governmental

organizations. SARH's newly acquired responsibilities for wildlife have prompted it to establish research and working priorities based on both the Forestry Act of 1992 and MEPA-1988. These wildlife priorities are as follows: (1) restoration of natural habitats for native flora and fauna; (2) protection of wetlands as habitat for aquatic birds and native wildlife; (3) development of integrated models of forest ecosystems for the use (harvest) of native flora and fauna; (4) development of models for integrated forest management within protected areas (forest reserves, national parks, and wildlife sanctuaries); and (5) models of range management around protected areas to prevent or limit grazing and habitat conversion within these areas.

THE ROLE OF MEXICAN RURAL COMMUNITIES

Mexico's system of land ownership and tenure determines the extent to which conservation goals and sustainable forestry can be established. Much of Mexico's land is either privately owned or managed by rural communities, and therefore, conservation education aimed at these landowners is a high priority. For sustainable land use practices to be effectively implemented in Mexico, education efforts, financial assistance, and cooperative projects must be coordinated at the rural community level. We describe two examples of development plans that illustrate how rural communities can successfully retain both their forests and their traditional independence, while still maintaining economic progress. These models also exemplify how sustainable development in Mexico can, perhaps by coincidence, benefit the conservation of habitats and populations of migratory birds.

In tropical southeastern Mexico, in the state of Quintana Roo, residents of several southern and central ejidos (community-owned rural townships) cooperated in instituting a sustainable forestry program, "Plan Piloto Forestal", with assistance from Mexican and German foresters and Mexico's Subsecretariat of Forestry and Wildlife (SARH). Since 1985, they have compiled forest inventories, planned cutting schedules, carried out selective logging operations, manufactured lumber and secondary wood products, controlled the business aspects of their forestry operations, and most importantly, established permanent forestry areas with the policy that sustainable forestry, not cattle ranching, will be the economic basis for future rural development. These ejidos encompass more than 525,000 ha of tropical forest. Additional activities under this plan include fire control, prevention of illegal cutting, reforestation of former cattle pasture land, forestry research, and spontaneous designation of natural reserves that are off-limits to any logging (Lynch 1992).

In temperate western Mexico, in the state of Michoacán, a similar sustainable forestry program has been developed by the Indian community of San Juan Nuevo Parangaricutiro, on its 19,000 ha communally owned township. This community uses intensive forestry techniques to manage its permanently designated forestry unit of 10,000 ha of pine-oak forests. This area is part of an extensive forested area, including an experimental forest to the east (Campo Experimental Barranca del Cupatitzio; 450 ha), and a national park to the west (Parque Nacional Pico de Tancitaro; 29,000 ha). The Indian community has developed a holistic forestry industry that represents the economic base and main source of labor for the inhabitants of San Juan.

INFORMATION AND TECHNOLOGY TRANSFER NEEDS

A need exists to address the priorities outlined in the last section, which would help to sustain and restore habitats for migratory landbirds and endemic wildlife in Mexico. However, three obstacles hamper these efforts: 1) lack of funding for wildlife research and management; 2) a shortage of qualified personnel; and 3) inadequacy of existing information, data bases, and data retrieval technology.

These problems can be resolved if techniques and funding for transfer of research information and up-to-date technology were improved at international, national, and local levels (WRI 1992). Developed countries can transfer technology to less developed countries, provide advanced training to Mexican nationals, and help to finance in-country conservation projects that serve to conserve and restore ecosystems and natural resources. Incentives for technology transfer should be particularly high if natural resources targeted for conservation are shared by both developed and less developed countries.

At the national level, technological support is needed by all governmental and non-governmental organizations interested and involved in protection and use of Mexico's natural resources. At the local level, human communities need to be involved in the management and conservation of natural resources that are the bases of their livelihoods. To sustain forests and related resources while continuing to receive economic benefits, local inhabitants need assistance and access to appropriate, environmentally-sound information and technology. The Neotropical Migratory Bird Conservation Program is an example that can supply necessary research information and technology for the conservation, management, and restoration of wildlife habitats in Mexico.

INTERNATIONAL EFFORTS FOR NEOTROPICAL MIGRATORY BIRDS

In 1990, the USDA Forest Service joined with the National Fish and Wildlife Foundation and seven federal partners to initiate a program for the conservation of neotropical migratory birds. The program, Partners in Flight, addresses the population declines of neotropical migrants through a comprehensive framework of research, monitoring, and applied management. Program participants acknowledged that population declines were probably associated with habitat problems in both temperate North America and the Tropics. To effectively conserve neotropical migrants, it was agreed that cooperative efforts were needed by all Western Hemisphere countries that share them. At the first annual meeting of Partners in Flight held in Atlanta, Georgia, in December, 1990, the U.S. Forest Service along with the U.S. Fish and Wildlife Service, and other federal, state, and private organizations designed a cooperative North American strategy for neotropical migrant conservation, focusing primarily on the goals and components of the domestic program.

The major research goal of Partners in Flight, as defined in the Atlanta report, is to "generate, synthesize, and communicate the information necessary to identify and implement appropriate conservation and management measures for the maintenance of healthy population of neotropical migratory birds, including the recovery of declining species." To assist in achieving this goal, a Research Working Group (RWG) was established. Within this group, a Western Hemisphere Subgroup (WHS) was formed to address international research objectives. The major goal of the WHS as defined in the 1991 RWG charter is to "promote participation in the Partners in Flight Program by Western Hemisphere scientists, resource personnel, and agencies in achieving program goals", including Mexico.

Research needs were originally outlined at the first annual meeting of the Partners in Flight Research Working Group and by Latin American and Caribbean ornithologists at a neotropical migratory bird workshop held in Quito, Ecuador, November 2-3, 1991. In addition, on August 8, 1991, Forest Service representatives of the Institute of Tropical Forestry, International Forestry (IF), Southern Region (Region 8), and WO Forest Environment Research, met with personnel of the U.S. Agency for International Development (AID) and National Fish and Wildlife Foundation in San Juan, Puerto Rico. Several areas of research important to the Forest Service were identified at the San Juan and Quito meetings and in subsequent interviews with meeting participants. Greater efforts are needed to match research priorities identified by in-country institutions with those identified by the Partners Stationin Flight program.

Analysis of Information Needs. We need to evaluate the status, amounts, and vulnerability to disturbance of different habitat types in tropical countries such as Mexico, and their relative contributions to biological diversity and viable populations of migratory birds. Recommendations and methods for protecting specific areas and high priority habitats possibly can be developed from inventories and syntheses of existing information. If existing information is insufficient, research and conservation priorities can be identified based on gaps in program coverage. Currently, the International Council for Bird Preservation (BirdLife International) in cooperation with Partners in Flight International Working Group (IWG) is preparing a Neotropical Migratory Birds Strategy Plan for the Latin American and Caribbean (LAC) Region. This strategy plan will be used to help identify needed LAC program areas for which Forest Service research and conservation efforts could be initiated or intensified.

Status and Distribution of Migrants. Lack of basic information about the status and distribution of migratory bird species in Latin American and Caribbean countries inhibits conservationists and in-country governments from taking steps to conserve their habitats and populations. Research is needed that clarifies where neotropical migrant species migrate and reside during the northern winter (i.e., what countries, protected and nonprotected areas, and habitat types); for how long; and at what population levels. Species that are at risk should be identified in relation to patterns of distribution, habitat use, probability of survival, and rates of habitat loss. To increase conservation effectiveness, research and management priorities already set by in-country governments and institutions should be considered when identifying projects, plans, and methods for conserving high-risk migrant populations.

Population Monitoring Methods. Research is needed to evaluate the reliability of different bird count methods in neotropical regions; to identify the most appropriate count methods for different situations; to evaluate and assist in the coordination of survey programs currently underway; and to determine the feasibility of implementing region-wide monitoring systems, especially in the Caribbean Basin. Are the monitoring methods typically applied in the LAC region (e.g., mist-netting, point counts, banding stations) adequate to distinguish population changes over short and long periods of time and among different habitats, including different disturbance regimes, successional stages, and silvicultural and agricultural options? What improvements or changes in methodology are recommended?

Plantation Forests and Noncommodity Resource Values. Research projects are needed that identify the characteristics, market value, and noncommodity resource value of native tropical trees. In LAC countries where silviculture is practiced, plantations of exotic pines are typical. Tree plantations comprised of native tree species may have greater habitat value to neotropical migrants and

resident faunas than those planted with exotics. Needed research includes comparisons of avian habitat use of exotic plantations and native tropical forests; development of ecologically sensitive methods for sustainable tropical forestry (i.e., sensitive to requirements of wildlife and intact ecosystems); and evaluations of faunal responses to new tropical forestry methods.

Forest Rotation Age. Field projects are needed to assess the short-term and long-term socioeconomic benefits of managing community and commercial forests of native tree species on rotation periods that differ temporally. Benefits to neotropical migrants and resident faunas would also be evaluated. Current evidence suggests that second growth forests with fallow periods greater than 20 years are used by more forest-dependent species of neotropical migrants (Askin et al 1990).

Forest Restoration and Regeneration. Technology is needed for restoring and regenerating native tree species in deforested and eroded areas of Mexico, Central and South America, and the Caribbean Basin. Integral to such projects would be evaluations of faunal responses to different restoration strategies in order to identify those methods that have most immediate benefit to native wildlife populations, including populations of neotropical migratory birds.

Agroforestry, Agricultural Habitats, and Pesticides. Agroforestry practices can be improved so that plantations simultaneously create habitats of use to neotropical migrants and other animals while meeting human needs for agricultural products like coffee and fruit. Studies are needed that compare avian use of a variety of agricultural habitats, including those with little or no native trees or scrub to those with an extensive tree canopy. Studies that determine migrant responses to pesticide use in agricultural lands are especially needed.

Pastureland Experiments. Projects are needed that evaluate the economic feasibility of planting native trees, shelterbelts, and woodlots in pasture lands; encourage the planting or regeneration of native trees for neotropical migrants; assess the value of pasture tree plantings to migrants; and assess and promote means other than livestock rearing for sustaining local human communities.

Landscape Change and Tropical Deforestation. Studies are needed that compare large scale changes in amounts of tropical forests to population trends of migratory and resident birds. Summaries of landscape data from remote-sensing projects, Geographic Information Systems, and other large-scale land inventory assessments are needed to update our understanding of rates of tropical deforestation, to pinpoint geographical regions with highest rates of forest loss, and to target conservation and educational efforts in these high-priority areas. The multi-million dollar project, Forest Inventory Assessment 1990, sponsored by the Food and Agriculture Organization of the United Nations (FAO) may provide substantial information in this regard.

Approaches Used by the Rocky Mountain Forest and Range Experiment Station

To take advantage of opportunities to cooperatively study and conserve a shared resource, wildlife scientists in the Rocky Mountain Forest and Range Experiment Station (RM) are working with Mexican scientists and government officials to define research priorities for neotropical migratory birds in Mexico. The brochure "Neotropical Migratory Bird Research at the Rocky Mountain Forest and Range Experiment Station" (1991) outlines RM's research goals in relation to Mexico.

Research on Wintering Migrants in Mexico. Species-specific responses to pasture conversion, buffer-zone agriculture, and timber harvest of temperate Mexican forests have not been determined for western migrants wintering in high concentrations in western and southern Mexico. This research will focus on population responses of migrating and wintering migrants to human-induced changes in native tropical dry forests, cloudforests, temperate forests, and riparian corridors, and on bird habitat relationships in pastures, native scrub, second growth, and late successional forests. Species at greater risk from clearing and agricultural use of tropical and temperate forests and riparian woodlands will be identified through community-level comparisons of population levels, seasonal habitat use, and survival rates of migrants. Species known to be North American forest obligates and dry scrub specialists will be evaluated using mist-netting, banding, and behavioral studies. Studies will be conducted in coordination with Mexican scientists, government agencies, and conservation organizations. The Nature Conservancy (TNC) in Tucson, Arizona has been assisting RM scientists by soliciting ideas and sites for potential research from participants in the TNC Parks in Peril Programs; by helping to identify Mexican cooperators; and by guiding RM scientists into potential research areas in Mexico.

Training Program for Mexican Biologists. RM wildlife scientists were awarded a grant in FY92 and FY93 from IF's Tropical Forestry Program (TFP) to design a training program to bring Mexican biologists, reserve managers, and students to the United States to work on survey, research, and administrative projects dealing with neotropical migratory birds. Mexicans receive training as Forest Service seasonal volunteers stationed on National Forests and Grasslands and/or with Experiment Stations. Funding through TPF covers roundtrip travel costs of volunteers from Mexico to the project location, coordination of travel logistics, information packets about neotropical migrants, and incidental expenses for supplies and equipment. The specific project provides housing and pays per diem to cover living expenses of the volunteer(s).

INTERNATIONAL FORESTRY

In 1990, the Forest Service initiated a new International Forestry branch that complements forest conservation efforts of other organizations such as the U.S. Agency for International Development and United Nations Food and Agriculture Organization. The International Forestry branch provides technical assistance, training, and support to international organizations. Resources in these categories are used to help countries meet immediate technical needs and raise skill levels. IF is designed to support, and participate in, projects of special interest and concerns such as those identified by Partners in Flight.

Strategies

Practical goals, activities, and projects designed to promote the conservation of neotropical migrants and their habitats in Latin American and Caribbean countries are defined in the charter objectives of the Partners in Flight International Working Group (IWG). Funding through International Forestry, Forest Service Research, and other potential Forest Service initiatives such as "Forests for the Future" could help to support priority activities already identified by the IWG. In addition to programs already implemented by the Forest Service (e.g., Sister Forest Program, Training Program for Mexican Biologists), the following training and technical assistance projects are recommended:

Population Monitoring. Few quantitative data are available on population trends on wintering migrants, and no regional monitoring strategy is currently in place in the Neotropics. To assess long-term population responses to forest clearing and other land use activities in tropical regions, population monitoring networks and national data banks must be established. Training in bird inventory techniques and data base management can be provided to interested participants of developing countries through cooperative activities with local, governmental, and international organizations. The success of a tropical monitoring program will depend on the internal coordination of Latin American and Caribbean organizations, technical experts, and volunteers.

Training and Information Modules. Preparation of bilingual information packets or education modules is recommended so that Forest Service personnel on technical assistance assignments in Latin America and Caribbean countries can involve local communities and organizations in Partners in Flight.

Communications Networks. A communication network could be developed to link Forest Service personnel, international organizations such as FAO and AID, and local conservation groups and government agencies in Latin America and the Caribbean Basin. A list of mailing addresses could be prepared for disseminating educational brochures and newsletters written in Spanish to local forestry officers, wildlife managers, and researchers. Existing mailing lists managed by FAO, FS-IF, and others should be used so that efforts are not duplicated. For example, a proposal could be submitted by one of the Partners in Flight working groups to create a Partners in Flight network in Latin America.

Student and Employee Exchanges. Exchanges of scientists, managers, and students could be arranged between the United States and tropical countries. Exchanges would address training and research needs involving the conservation and management of native tropical forests and faunas.

Training Programs and Workshops. Latin American training programs and workshops are needed to encourage forest restoration and regeneration, bird and habitat monitoring, and sound management of tropical forests by local biologists, reserve managers, university researchers, and foresters.

Special Assignments. By authorizing international assignments for wildlife experts to visit developing countries, the Forest Service can help Latin American citizens to develop in-country programs for monitoring and conserving migratory bird populations.

CONCLUSIONS

The need to conserve global forest resources continues to accelerate because of human population growth and increased consumer demands for wood products. How can agencies in the Western Hemisphere hope to address concerns dealing with deforestation across international boundaries? We recommend that agencies in developed countries develop and transfer information and technology on ecosystem-based, multiresource management approaches to Mexico, Central America, and other Latin countries. To balance economic needs, public expectations, commodity production, ecological values, and concerns for maintaining biological diversity and environmental quality, governments in developing countries will need to set policies for sustainable use and development of natural resources. This approach must entail a shift in management emphasis from sustaining yields of competing resource outputs to sustaining ecosystems and their interacting components (Kessler et al. 1992).

Although the Mexican legal system has begun to address conservation of natural resources, and the concept of sustainable development has become part of the federal government's nomenclature, enforcement is not uniformly effective. Erosion of Mexico's environmental quality continues through illegal exploitation of Mexico's forest resources and the high rate of deforestation in tropical ecosystems. Nonetheless, alternatives to deforestation are developing at local levels, generated by communities that

still hold large forest tracts. We described two models of sustainable forestry currently practiced by rural communities in different parts of Mexico.

We believe that conventional conservation techniques, such as land preservation via parks, reserves, zoological parks, and other protected areas where most human activities and uses are prohibited, do not address the fundamental causes of biodiversity loss and habitat destruction. When the establishment of natural reserves in developing countries does not include the participation of local communities, these inhabitants typically resort to environmentally detrimental activities (i.e., poaching, illegal logging) in order to support their families. Biosphere reserves are a recent improvement over traditional conservation strategies because limited human use is allowed in buffer zones; because traditional subsistence of local communities is allowed to continue; and because training and education programs are developed to target local communities. To protect areas as biosphere reserves, lands must usually be purchased first. In addition, community involvement in developing the reserve may be minor. Such factors limit the applicability and success of the biosphere reserve approach to conserving natural resources.

Fundamental reasons for losses of biodiversity and habitats, as identified by the Global Biodiversity Strategy (WRI 1992), are growing human populations and concomitant increases in human use of resources; inadequate knowledge of the ecology and interactions of species, habitats, and ecosystems; weak or ineffectual governmental policies; inequity of resource valuation and distribution; and failure of economic systems to attribute value to biological resources.

Although the problems we have outlined will be difficult to solve, we believe that the implementation of policies and methods for practicing ecology-based sustainable forestry will be critical for meeting human needs and conserving global biological diversity, including the species diversity of neotropical migratory birds shared by Mexico and the United States.

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